Telegraphic Address: "Ageckay, London." ABC Code. [Registered at G.P.O. as a Newspaper.

VOL. XXVI.]
No. 639.]

FEBRUARY 21, 1890.

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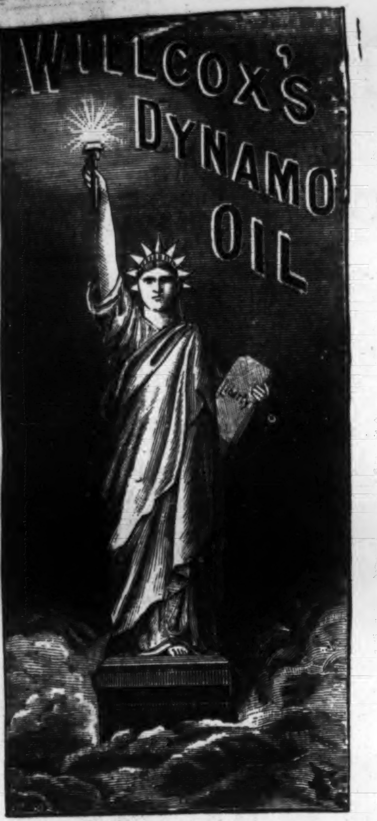

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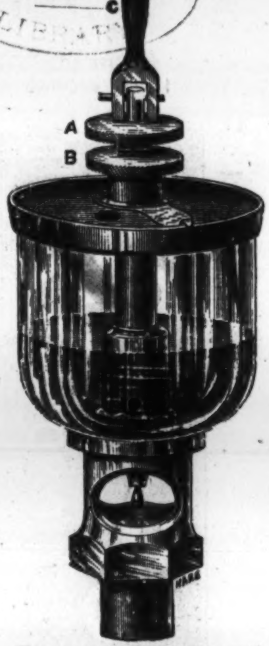

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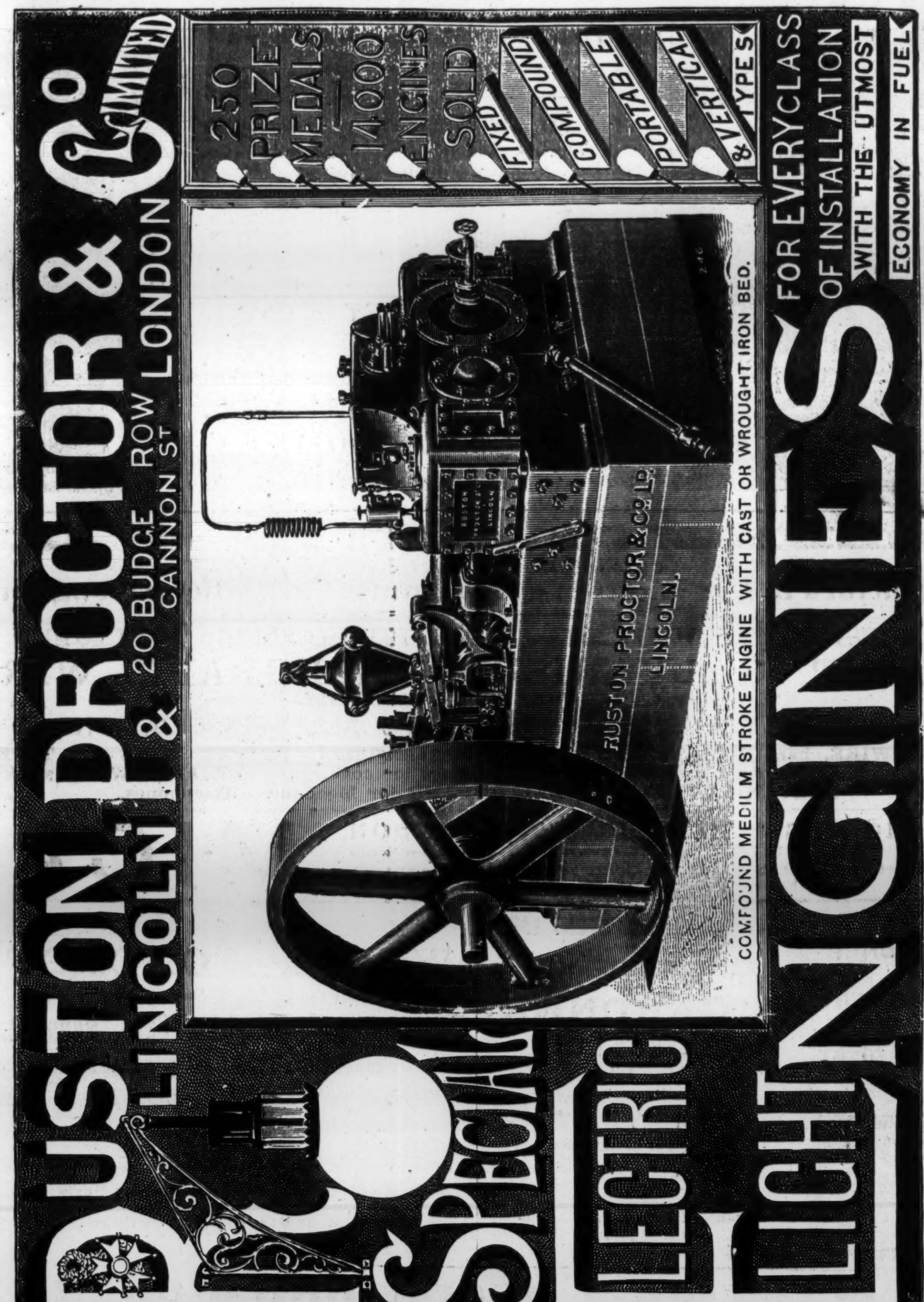

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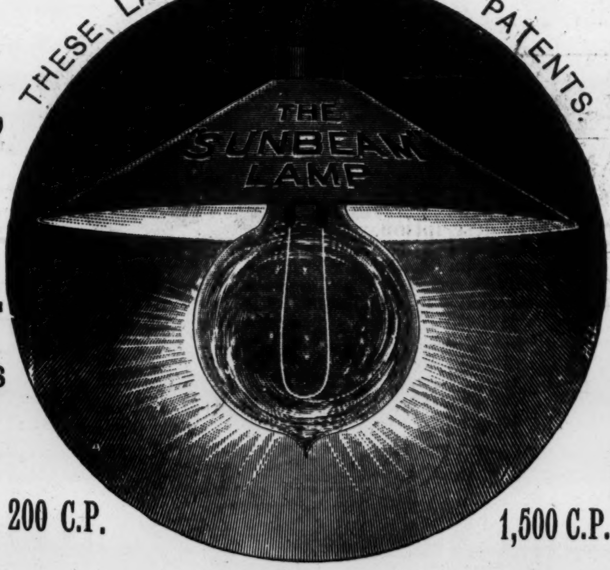

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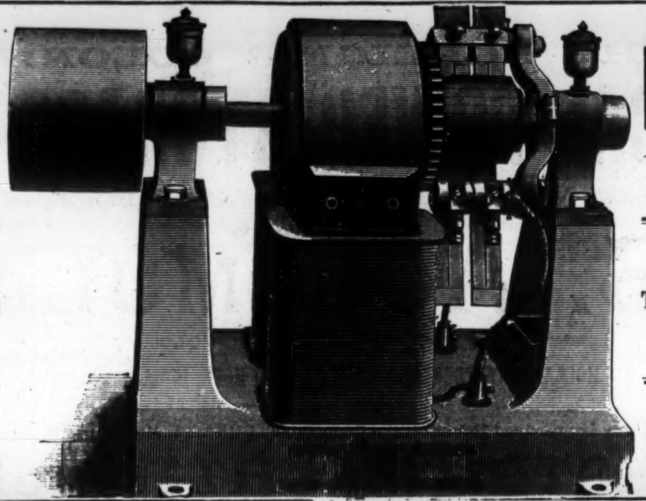

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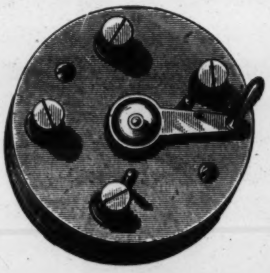

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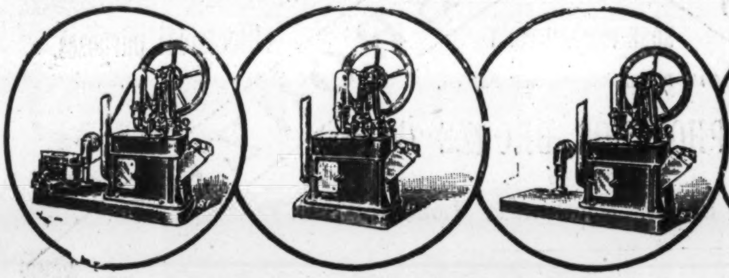

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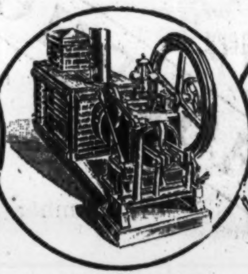

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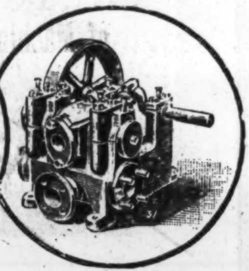

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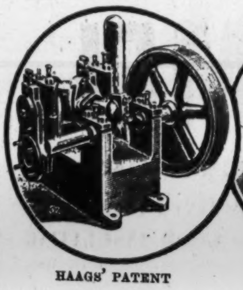

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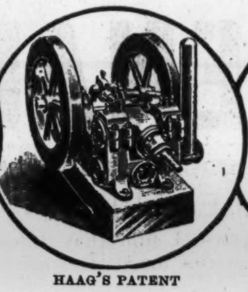

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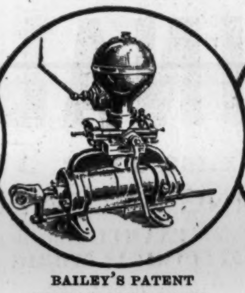

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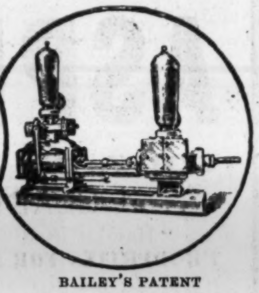

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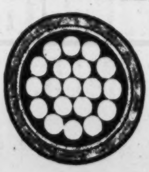

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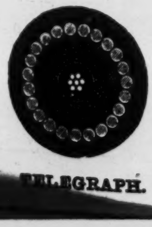

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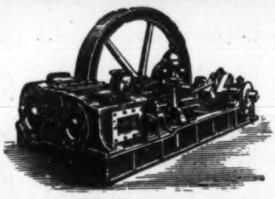

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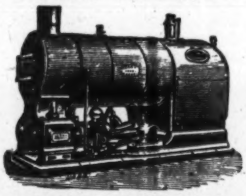

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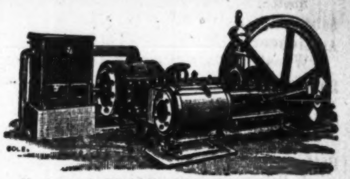

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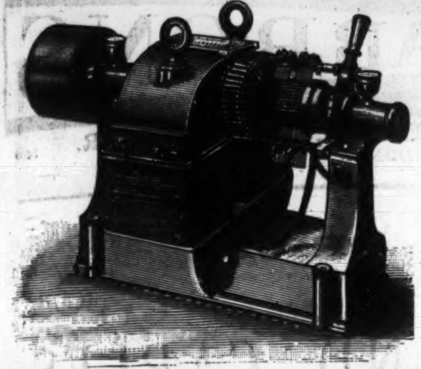

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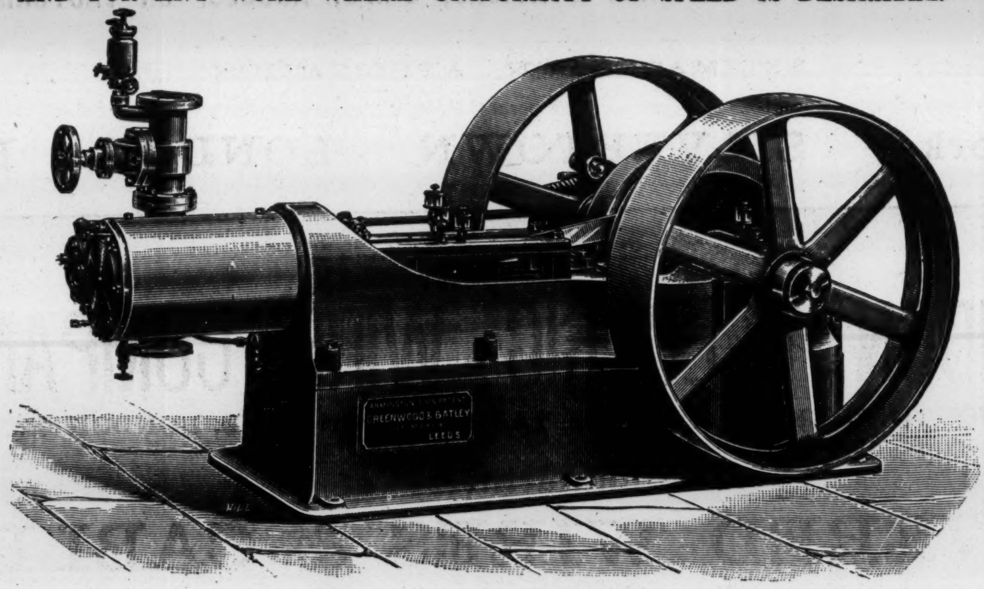

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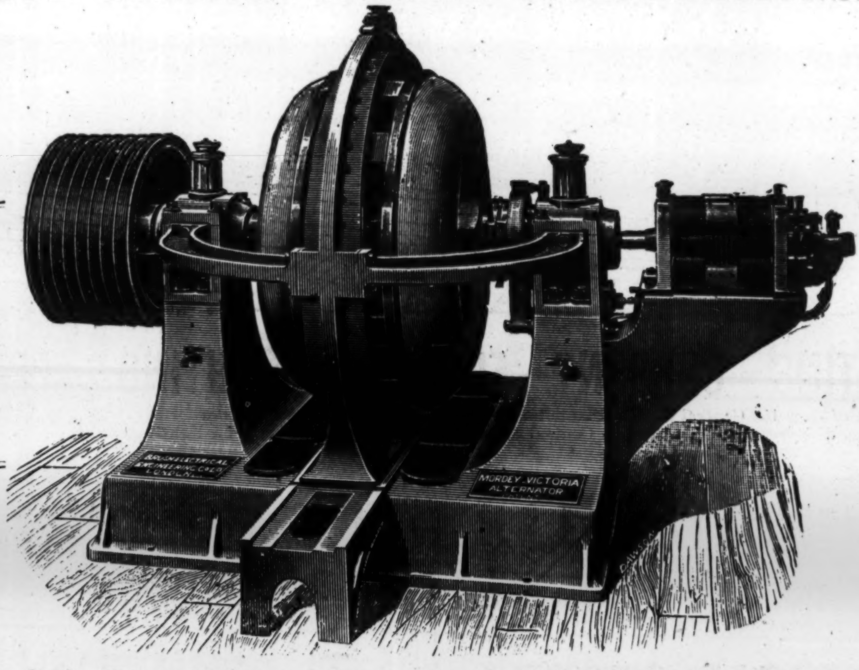
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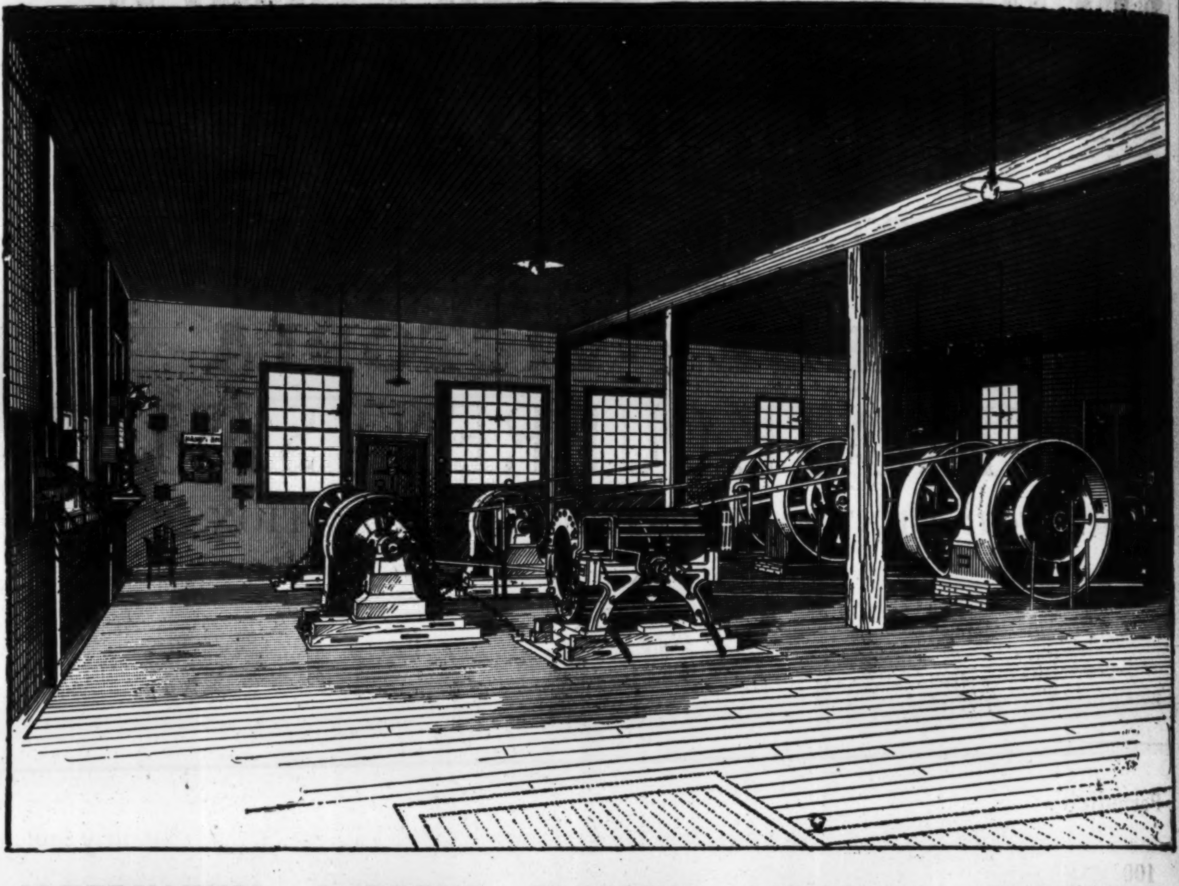

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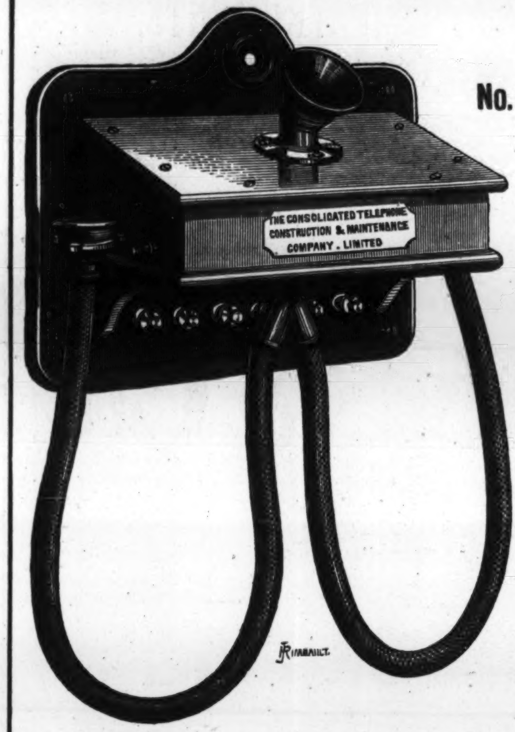
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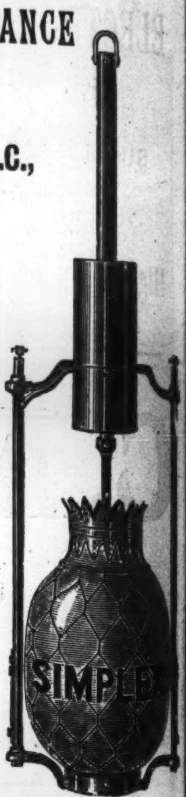

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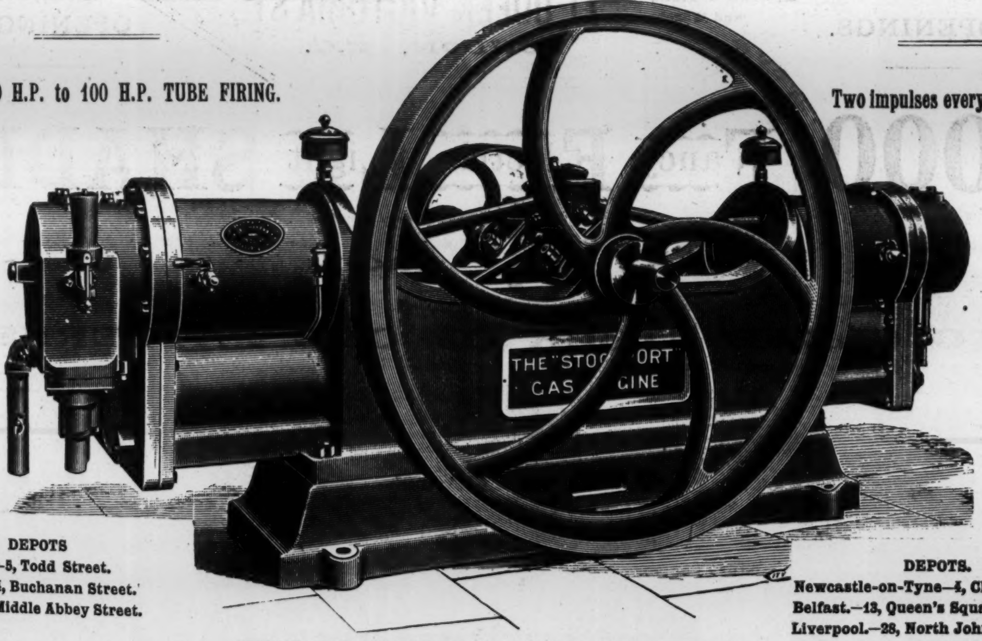

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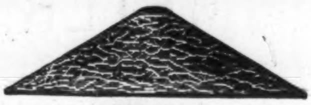

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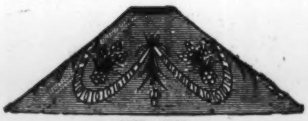

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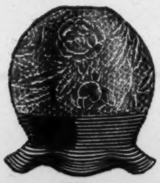

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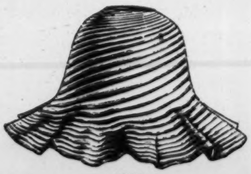

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THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXVI. FEBRUARY 21, 1890. No. 639.

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ELECTRIC LIGHTING.

AT a recent meeting of the Electrical Section of the London Chamber of Commerce Mr. Crompton, the Earl of Crawford, and Major Flood Page, were asked to address a letter to the *Times* with reference to the fire that recently took place at No. 8, Grosvenor Square, in which house the electric light was used, and also with reference to the danger which it is alleged is connected with the use of the electric light.

Owing to a combination of circumstances a joint letter was rendered impossible, so, on Monday, the gallant Major took upon himself the responsibility of a lengthy epistle to the favoured of the daily press. The arguments of the writer are, in several places, somewhat contradictory, and his similes are not always to the point. As an instance, he says :—"It seems clear that the battle between high tension and low tension will be fought just as the battle between the broad gauge and the narrow gauge has been fought out by the railways, and we shall eventually, perhaps, have only one system in general use. As in the case of railways, and in many other things, we may expect the survival of the fittest. I shall not venture to express an opinion as to which system will eventually survive."

It is difficult to see the force of the Major's reasoning here, for over long distances high tension currents must *necessarily* be employed if commercial success is aimed at. The permanent ways of railways may certainly be likened to electrical conductors, for both convey something from one point to another, but here the simile ends ; whether a railway is short or long the same gauge answers equally well, but the case is very different for long or short distance transmission of electrical energy.

Whatever may be the motive which led the worthy secretary of the Edison-Swan Company to pen his lengthy letter to the *Times* (and we know that he generally has some object to serve whenever he appears in print at opportune moments) he has drawn the attention of the public to several very important factors which enter into the proper fitting up of electric lighting installations. He shows very clearly that the fire to which he alludes was, in the main, due to the imperfect and unworkmanlike manner in which the wiring had been carried out ; "not in accordance with any fire insurance rules," as Mr. Heaphy's report puts it. Major Flood Page also comments upon the position occupied by uninsured houses, where the only power of inspection is that the supply company may refuse to turn on current until satisfied that the interior fitting has been satisfactorily completed. All this, as the writer remarks, will be rectified in time, and he recommends that householders installing the electric light should withhold the payment of their bills until they secure the certificate of a competent electrical engineer or fire insurance expert, to satisfy them that everything has been done with a due regard to safety.

The figures below, which he quotes from Captain Shaw's annual report on fires within the metropolitan area, show even more clearly than those we published last week from American sources how little danger of a conflagration is to be apprehended by users of the electric light ; but it must be borne in mind that such data is misleading, if taken literally. From these reports it appears that the number of fires within the metropolitan area which have been caused by candles, by gas, and by lamps, is as follows :—

	1887.	1888.	1889.	Total.
Candles	142	113	136	391
Gas	188	197	209	594
Lamps	245	205	257	707
Electric light	—	1	2	3

"It is hardly necessary," says Major Flood Page, "to say that the number of electric lamps in use is but a small percentage of the number of the other lights. Nevertheless the fact remains that we have now in the metropolitan area an annual average of 565 fires which owe their origin to lamps, to gas, or to candles, and have as yet had only four fires from the use of electric light. The number of fires caused by gas and lamps throughout the world is really appalling."

Perhaps so; but what we want to get at is the number of houses in London lighted by each of the illuminants named, and then to ascertain what percentage the residences which have suffered by fire bear to the remainder. Even then the comparison is not strictly true, for candles may cause an outburst of fire in even an electrically-lighted mansion as we can scarcely hope to see the modest dip entirely eliminated from the household.

Towards the end of the lengthy letter from which we quote occurs the following passage :—"To avoid misapprehensions, I should like to say that as neither of the companies with which I am connected undertake installations or the wiring of houses, I am quite impartial, and have no interest to serve except to aid in the removal of any prejudice which the sensational narratives have created, and to assist in allaying alarm for which there is no foundation."

Previous to this, however, there is a paragraph to which some people of a not altogether guileless nature might ascribe the *raison d'etre* of the correspondence :—"I believe that there is an absolute consensus of opinion amongst all those competent to judge, that electric light on a low tension system, at any rate, may be brought into houses in which the whole of the internal arrangements have been carried out in accordance with the rules of the best insurance companies with greater safety than can be obtained with any other artificial means of lighting. I say low-tension system advisedly, for when we speak of high tension we enter the region of controversy, and some of the opponents of high tension are perhaps inclined to exaggerate the danger from its use."

However, whatever may be the cause which determined Major Flood Page to give his views on the situation at such length, it must be acknowledged that he has done yeoman's service in the cause of low tension, and thereby probably pleased the greater number of his readers; he has, moreover, rendered a real service to the community at large, for nobody is likely to deny that his final conclusions are perfectly just. "I think," says the Edison-Swan representative, "that the public may rest assured that while the employment of electric lighting does not altogether get rid of the liability to accidents which is inherent in everything human, and which at present reaches a most serious percentage in the case of all ordinary artificial illuminants, yet it tends to reduce the risk to a minimum, far below the chances of fire from candles, oil, and gas. The extent of the security is, however, in exact proportion to the skill and care exercised by those who wire the house; while cheap work is in nearly every department of life poor and bad, in wiring for electric light it is simply fatal. I am confident that when a competent electrical firm is employed and a fair price paid for the wiring, &c., of a house; when a consulting electrical engineer, or a competent fire insurance expert is called in to report upon the work before it is paid for, that those who introduce electric light into their houses may enjoy, amongst other advantages, a sense of security from fire not to be attained by any other means of lighting their houses. I venture to suggest that every householder whose house has been wired by anyone not an electrical engineer should call upon the office in which his house is insured, or if uninsured upon an electrical engineer, to inspect and report upon the electrical apparatus which has been fixed in his house; and to those who are at present thinking of having their houses wired I would suggest that they should entrust the work to some electrical firm of known standing, of which there are several."

CHEAP TELEGRAPHIC COMMUNICATION.

IN a paper read before the Society of Arts on Tuesday afternoon on "Ocean Penny Postage and Cheap Telegraphic Communication," Mr. J. Henniker Heaton, M.P., hit out strongly at the monopolies held by the telegraph companies who, he said, conducted their business for their own benefit and not for that of the public. The result of this was the present high rates charged per word for communication between England and her colonies. He strongly deprecated the positions now occupied by the Eastern Telegraph, the Eastern Extension and the South African Companies who, with Sir John Pender, "the wily spider of this vast web," had so distributed it that it was difficult to oust him from his position of supremacy. Owing to this state of things international communication was very limited, and to remedy this he proposed the laying of a cable at a cost of £2,000,000 from Australia *via* Fiji to Vancouver, the Pacific terminus of the Canadian Pacific Railway, there connecting it with the line through Canada and across the Atlantic to Valencia. He also suggested the purchase of the Eastern Extension Company's cable for £2,200,000, thus extinguishing subsidies to the extent of £56,700 now paid by the Colonies. The outcome of this would be that the total annual charge for the acquisition of complete State control over the Pacific and Asiatic telegraph routes would amount to £65,000,000. An immense reduction in rates would then take place, and the Imperial telegraphs taken as a whole would, with reduced charges, according to Sir John Pender, afford a profit of £1,000,000 per annum. Mr. Heaton, after referring to the four available telegraphic routes to India, proposed the construction of a land line, if possible, from across the English Channel to Calcutta and Bombay. He then touched upon the two alternative routes suggested by Mr. Pitman. The first was an overland line through Southern Afghanistan, to join the Indian system terminating at Chaman, and the Russian system near Penjdeh. The second was a line from Fao to Constantinople, the lines from the former place to Kurrachee being multiplied. The former he termed the Afghan, and the latter the Turkish route; but he believed the Afghan route would be the one first selected, although the other was, in his opinion, the best, and would sooner or later be utilised. In conclusion, he contended that the only direction in which reform lay was in the acquisition or construction by the State, on behalf of the Empire, of a sufficient network of sea and land lines, the result of which would be a great improvement in the telegraph service to and from the Colonies and India.

Bradford. Lamp Renewals.

IT is thought in some quarters that the breakage of lamps in Bradford, said to be due to variations in the pressure, is produced by something apart from this. At one large place, for example, which was formerly lighted from a private installation *working at a very low pressure*, the Corporation current very soon made itself felt, and a complete set of new lamps had to be put in. Our readers may not be aware that all shop fittings are done by firms—not by the Corporation—and lamps seem to have been put in that were never intended to work at the Corporation pressure. A correspondent knows of a place where lamps went right and left for the first few weeks, and the firm that put them up came and asked permission to replace them at its own expense. The new lamps have been in use for five weeks *and none of them have broken.* Had the breakages in the first place been due to the Corporation, it would have had to "pay the piper." Again at a billiard room in the town, where 50 lamps are burning for long periods, and where the light has been in use for two months, only one mishap has taken place, and that was caused by an accident. We understand that the leakages in the mains have now been eliminated.

The Bradford Lighting.

THE Corporation of Bradford wish it to be understood that a statement recently made at a meeting of the Leeds Town Council to the effect that Bradford had made a mistake in adopting low-pressure electricity instead of the high-pressure system, and were about to incur an expenditure of £10,000 in altering their plans, is quite without foundation. The Corporation, who were advised by eminent electricians before commencing their works, consider that the results obtained from the low-pressure system now in use have been highly satisfactory, and the expenditure of more money is rendered necessary by the increasing demand for the light. Another engine and dynamo with feeding mains to a busy quarter of the town are about to be laid down. It may be stated that up to the end of last year the expenditure upon the Bradford works had reached £26,013. During the two months that the light had been in use the revenue was £585.

Sir W. Thomson's Light Literature.

SIR WILLIAM THOMSON, it appears, is a contributor to the *North American Review*, which has recently published articles from Messrs. Edison and Westinghouse. The title of Sir William's paper is "Electric Lighting and Public Safety," but we fail to perceive anything in it which has not been better said over and over again in the technical journals. The Board of Trade regulations form the main theme of the article, and our great electrician is careful to steer clear of anything like an opinion except in one respect. He considers that the Board of Trade rules are amply sufficient guarantees against danger to man or beast in country districts from aerial electric light conductors, whether for high or low pressure; high pressure they must generally be for long ranges over country. Indeed, he thinks these regulations may be largely relaxed for electric light wires in the country. Provided only that strong enough and sufficiently well-engineered standards or well-stayed poles be placed for carrying the wires, and provided the spans from standard to standard be short enough, it will, he believes, be found quite unnecessary in respect to public safety to have any coat of insulating material on the copper of conductors for electric light or power along a country road. Fifty years may well pass, with all their gales and snowstorms, without a single breakdown, and there are no telegraph or telephone wires to fall upon the deadly copper with its 10,000 volts. Until, however, the security of the poles and wires, which Sir William believes to be attainable, is satisfactorily demonstrated, and until it is also proved that this security can be attained at moderate enough cost, he would not suggest the slightest relaxation of any of our Board of Trade regulations for the protection of the public safety, whether in town or country.

New West India Cables.

Le Temps of February 13th, 1890, publishes the news of the successful laying of the new cables between th islands of Martinique, Guadeloupe, and Marie Galante. These cables were laid by the *Pouyer Quertier* telegraph ship for the Société Française des Télégraphes Sousmarins. The total length of the sections is 118 N.M., one half of which was manufactured at the Bezons works of the Société Generale des Téléphones. The other portion of this cable was partially of new manufacture at Henley's works, Woolwich, and part consisted of surplus cable left over from the *Roddam* expedition of 1888, during which the same company's cables between Cuba, Hayti, Santo Domingo, Curaçaò and Venezuela were laid. We learn that the French Colonial Administration is in treaty with the Société Française des Télégraphes Sousmarins for the laying of another cable to connect Martinique with the French colony of Cayenne.

More Professional Etiquette.

TOWARDS the termination of Major Flood Page's letter, which has served us as the theme for several comments, we read that an electrical engineer should be called in to inspect and report upon the electrical apparatus which has been fixed in a house. This is good advice and is, we believe, followed in a great many instances; but *quis custodiet ipsos custodes?* An instance has been brought to our notice in which a well-known contracting firm arranged to fit up a country house. The owner was advised by a consulting engineer, who disapproved of certain switches, cut-outs, fuzes and what not, which had been generally employed by the firm during a very extensive practice; these, he said, must be abandoned and others substituted, for which he would send patterns. Imagine the feelings of the contractors when the patterns arrived with the name of the consulting engineer upon them as patentee? We believe they refused point blank to use the selected apparatus; but what must such proceedings as these create in professional circles? If something is not done to put a stop to such breaches of professional etiquette, we shall soon find the contractor and consulting engineer merged into one and the same individual.

SUBMARINE CABLE CONCESSION FOR SURINAM AND CURACAO.

THE Administration of Dutch Telegraphs has issued the following official notification :—

The two concessions granted to the Pedro Segundo Telegraph and Cable Company (*vide* pages 214 and 215 of the *Journal Telegraphique* of September 25th, 1888, No. 9) have been annulled by the Governors of Surinam and Curaçao, the said company having failed to establish cable communication within the period fixed upon in the concession.

Consequently, the Governor of Surinam has granted, by a decree of the 18th of September last, to the Société Française des Télégraphes Sousmarins, a concession whose object is the connecting of the town of Paramaribo with any point in that company's system, and through this system with the general scheme of telegraphic communications.

The cables mentioned must be laid and placed in working order within the period of one year and a-half from the date of the concession.

The Société Française shall also connect Paramaribo with Cayenne (French Guiana) as soon as a concession has been obtained from the French Government.

The rates per word for the transmission of telegrams interchanged with the colony of Surinam by the cables of this concession are adjusted as follow :—

Between Paramaribo and	Francs per word.
Venezuela	6.00
Curaçao	5.00
Santo Domingo	4.50
Haiti	5.00
Santiago de Cuba	6.00
Martinquie	2.00
Guadeloupe	2.50
New York	8.00
Cayenne	1.00

The official telegrams of the Dutch Government and of the Government of Surinam transmitted over the lines of the Société Française shall be charged at half rates.

A terminal tax of 0.10 franc per word, to be paid to the colony of Surinam, shall be added on to above rates.

Telegrams in transit on these cables, that is to say, messages which neither originate at, nor are destined for Surinam, shall not be subjected to any colonial transit charge whatever.

From the day upon which the submarine telegraph communications herein previously mentioned are placed in working order, the Société Française shall receive, for a period of 20 years, an annual subsidy of 24,000 florins.

The Société shall comply, so far as concerns the telegraphic correspondence by its cables between Surinam and other countries with the laws of the St. Petersburg Convention of July 22nd, 1875, and of the Service Regulations attached to it drawn up at Berlin, September 17th, 1885, and also with whatever modifications may be made in these documents. On the other hand, the Government of Surinam will endeavour to obtain for the cables herein mentioned the application of the International Convention for the Protection of Submarine Telegraph Cables drawn up in Paris, 14th March, 1884.

The duration of the concession is fixed at 60 years. It can be cancelled by the Government of Surinam :—

1. If the communications herein previously mentioned are not completed and in working order within one year and a-half (that is to say, before March 18th, 1891).

2. If cable communication should be interrupted for more than six months. Should, however, the Société Française prove that it has been prevented by force majeure from re-establishing communication within the time specified, a prolongation of time may be granted.

During the period of 20 years for which the subsidy herein previously mentioned is paid by the Government of Surinam, no other concession may be given by the said Government for telegraphic communications between this colony and the countries mentioned in the foregoing table of tariffs, and during the whole of the concession the Société Française shall have the preference for all submarine communications in the colony in connection with those mentioned in the concession.

(The concession has been accepted by the Société Française* during the last few days by the deposit of caution money.)

PHYSICAL FIELDS.

The following letter has been communicated to *Science* upon Prof. Dolbear's article which appeared in the ELECTRICAL REVIEW of January 31st :—

Prof. Dolbear's interesting article on "Physical Fields," that appeared in your issue of December 27th, was called to my notice, and I have read it with considerable attention. It seems to me that he is entirely wrong in some of his premises, and that his conclusions are therefore, some of them, untenable. With your permission, I will point out where I differ with him.

His use of the term "stress" is certainly not correct. He says, under the head of "The Electric Field," "The phenomena are explained as due to the stress into which the neighbouring ether is thrown by the electrified body. . . . Experiment shows that this kind of a stress travels outwards with the velocity of 186,000 miles a second, or the same as that of light."

It does not seem to me to be proper to say that a stress travels : it rather exists. In this particular case he is referring to the phenomenon of electrification, which is a static effect or condition. As I understand Maxwell, and Hertz and Thompson and Lodge, they do not any of them believe that electrification involves motion in any way whatever. It is a condition which is dual in its character. The negative exists because of the existence of the positive, not because of propagation from one to another. They also believe that one cannot exist without the other : the very existence of one, therefore, involves the existence of the other. The element of time, and therefore of rate of propagation, must be eliminated entirely.

What he does mean is, that an impulse due to the yielding to this stress is propagated, &c.

Again he says, "If this assumed electrified mass of matter were the only matter in the universe, any electric change in the mass would ultimately re-act upon the whole of space, and be uniform in every direction." This statement involves a contradiction of terms, for how can we have a condition of stress that is uniform throughout all space? It is certainly true that under static conditions, or under conditions of stress generally, where there are two bodies or more concerned, the field is distorted by their mutual re-action (that constitutes the stress) ; but I maintain that where there is but a single body in space, there can be no such thing as stress in that space outside of the body itself. If the body in question be but a mathematical point, there can be no stress at all. There can be no tension on a cord that is perfectly free to move.

The same criticism is made upon his remarks under the head of "The Magnetic Field." In the case of the magnet the justice of my criticism will be, perhaps, more apparent. Were it possible to conceive of a magnetic particle with but a single pole, could we imagine that pole surrounded by a magnetic field? Our conception of the ultimate particle of magnetic matter endows it with two parts, which react upon each other. If there were but a single particle of magnetic matter in space, the "lines of force" would form closed curves within that particle, passing from pole to pole: they could not, without violating all the laws of stress, radiate off into space, as he says they would.

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* Our readers will recollect that the Société Française des Télégraphes Sousmarins are the owners of the submarine cables connecting Cuba, Hayti, Santo Domingo, Curaçao, and Venezuela. These cables were laid by Henley & Co. in the ss. *Roddam* in 1888. —EDS. ELEC. REV.

Under the third head, "The Thermal Field," we come to a very different class of phenomena. Here, as in the case of light, we have vibration: we have distinctly a condition of motion of the ethereal medium. We have passed from a state of rest—a static condition —a state of potential, to one of movement—a kinetic condition.

He says, "A hot body has a field, as well as an electrified or a magnetised body:" so it has; but his fundamental and fatal error is in not being able to discriminate between the two kinds of field. The magnetic, the electric, and we may add the field of the force of gravity, are purely static, purely potential, whereas the luminous and thermal fields are kinetic. In the former there can be no propagation, as the element of motion is entirely wanting. Add to these fields of stress the element of motion, and they at once become kinetic, and will then obey the laws of kinetic fields.

A potential field without motion will exist for ever: a kinetic field requires the continual addition of energy for its maintenance. Move a magnet, or the earth relatively to any other magnet or body, and kinetic fields are produced. Move an electrified body, or cause its field to change in any possible way, and we have again a kinetic field.

If, however, there be but a single body in space surrounded by a potential field, the movement of that body, while the movement in itself will constitute kinetic energy, still would not convert the potential energy into kinetic.

He says, "So, if there were but a single hot body in the universe, it would impart its energy to the ether and approach infinitely near absolute zero; while an electrified body or a magnet would be perfectly insulated, and, so far as is known, would lose none of its properties, however long it was thus kept. There is no static condition in heat phenomena: exchange is constant. These facts indicate that light or radiant energy is no more an electro-magnetic phenomenon than magnetism is a thermal phenomenon, but that it is one of a distinct order."

The only difference is that in one case there is stress alone, and in the other there is motion, a yielding of that stress. Take away motion from one, or add motion to the other, and the phenomena are identical in kind.

It is the difference between a reservoir full of water on a hill, and that same water in the act of falling from its elevation. It requires an expenditure of energy to fill the reservoir—to produce the stress or static or potential condition—but involves no expenditure of energy to maintain that condition. We have in the elevated reservoir of water the analogue of magnetism, electrification, gravity. Let this water fall from its position, and we have something that corresponds to light—the galvanic current, heat, &c. It requires the expenditure of energy to get these forms of energy, and it requires the expenditure of energy to maintain them.

We must regard electricity as motion; electrification, one kind of stress which is capable of producing electrical vibrations; magnetism may be another. We may compare magnetism, electrification, and gravitation to different tensions of a given string on a violin; and electricity, light, heat, &c., as the tones produced by that string when struck under these varying tensions.

NELSON W. PERRY.

Cincinnati, O., *January 15th.*

Institution of Electrical Engineers.—Mr. Swinburne's paper on "The Theory of Armature Reactions in Dynamos and Motors," read before the Institution of Electrical Engineers on the 13th, will be discussed conjointly with Mr. Esson's communication on "Some Points in Dynamo and Motor Design," set down for reading yesterday.

THE FISKE RANGE-FINDER.

IT has long been recognised as a prime necessity of effective gunnery at sea that the gunners shall know at each instant the exact distance of the ship or object at which they are to shoot. To realise this we must reflect that, if two ships are approaching each other at the rate of even 12 knots each, their distance apart is changing at the rate of 13⅓ yards per second. This means that in less than 4 seconds the distance or range will change 50 yards, which represents the distance apart of two consecutive graduations of the sight bar of a modern rifle gun; in other words, the sight bars of high-powered guns are usually graduated to 50 yards, and it is necessary for effective shooting that an error of 50 yards must not be made in estimating the distance and timing the discharge of the gun as the ship rolls from side to side. But if this change of 50 yards be made in 4 seconds, it is plain that we must have an instrument that will give the range with less than 4 seconds' delay, and give it, at the very least, with less than 50 yards' error. Such an instrument is called a "range-finder." A description of a new and exceedingly clever, as well as thoroughly scientific device, for ascertaining the range and position of distant objects, designed by Lieut. Bradley Allan Fiske, forms the subject of this article. A short notice of this invention appeared in the ELECTRICAL REVIEW on December 20th, 1889.

The invention consists of a new method of finding the range and position of a distant object, which depends upon the determination of a fractional portion of a conducting body bearing in length a ratio to the angle included between two lines of sight directed upon said distant object and the measurement of the electrical resistance of said length.

The drawings (from *Science*), are (fig. 4 excepted) all electrical diagrams, not drawn to scale, and symbolically represent the invention. In fig. 1 is shown a Wheatstone bridge, in one member (*a*) of which is arranged a body of conducting material in arc form, and a movable arm traversing the same. In fig. 2 is shown a Wheatstone bridge having arcs and movable arms arranged in two members, *a*, *b*. In fig. 3 is shown a Wheatstone bridge in which arcs connect adjacent members, as *a*, *c*, and *b*, *d*, and movable arms sweeping over said arcs are connected to the battery. Fig. 4 is a mathematical diagram illustrating the method of determining the angle, A, T, C. Fig. 5 shows a disposition of the range-finder in connection with a dead-beat galvanometer; and fig. 6 the same in connection with the slider. Similar letters of reference indicate like parts.

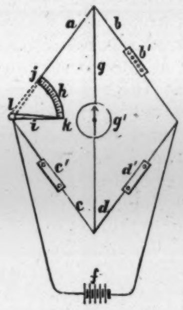

FIG. 1.

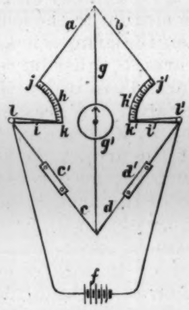

FIG. 2.

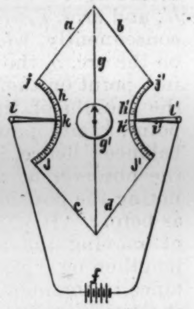

FIG. 3.

In fig. 1, let *a*, *b*, *c*, *d*, represent the four members of an ordinary Wheatstone bridge, and *g* the transverse member, in which is connected the galvanometer, *g′*. A battery, *f*, is also connected to the bridge in the usual way. In the members, *c* and *d*, are placed the fixed resistances, *c′* and *d′*, and in the member *b* the variable resistance, *b′*, also, as usual. One wire from battery *f*, however, connects to the end of member *c*, and also to the pivot, *l*, of a swinging arm, *i*. The extremity, *k*, of arm, *i*, moves over and maintains electrical contact with an arc, *h*, of conducting material, which has one extremity, *j*, connected, as shown, to the member, *a*, of the bridge. It is obvious that when the arm, *i*, is in the position shown in full lines in fig. 1, then the current will traverse the whole arc, *h*; and when said arm is in the position indicated by dotted lines (fig. 1), then the arc, *h*, will be cut out, and the current will pass directly to member, *a*. Now assume the arc, *h*, to be made of such material, and so proportioned that its electrical resistance to a current traversing it will be proportional to the length of arc included between the contact end, *k*, of arm, *i*, and the connecting point, *j*, of member, *a*, with said arc. Therefore the resistance interposed in the member, *a*, of the bridge will be commensurate with the angle, *j*, *l*, *k*; and if this resistance be known, the angle is also known. Let it now be assumed that the galvanometer, *g′*, and variable resistance, *b′*, be located at some point distant from the moving arm, *i*, from which said arm is invisible or inaccessible. Clearly, then, an observer stationed at the galvanometer, *g′*, and resistance, *b′*, can, by noting the galvanometer and adjusting the resistance in the usual way, determine the resistance equilibrating any position of arm, *i*, along the arc, *h*, and so discover the angle of adjustment of said arc; or, having adjusted the resistance, *b′*, at some given figure, the observer may, by simply noting the galvanometer or any other suitable indicating device, visual or audible, determine when the arm, *i*, is placed at a desired angle corresponding to the adjusted resistance, and this indicating device may obviously be at the place where the moving arm is located, so that the operator there may thus know when he has placed the arm at the predetermined point or at the distant station, so that the operator in charge of the resistance, *b′*, may know that the arm has been adjusted properly; or two indicating devices in the same circuit may give warning to both operators, as above, simultaneously.

Referring now to fig. 2, it will be apparent that, in lieu of the variable resistance, *b′*, in the member, *b*, there is arranged an arc, *h′*, and swinging arm, *i′*. The arc, *h′*, is connected at one end, *j′*, to the member, *b*, and the swinging arm, *i′*, makes contact at one end, *k′*, with said arc, and to its pivot, *l′*, is connected the member, *d*. The arrangement and construction of arc, *h′*, and arm, *i′*, are similar to those of arc, *h*, and arm, *i*; consequently, when the arm, *i*, is set at a certain point on the arc, *h*, the arm, *i′*, must be set at the corresponding point on the arc, *h′*, in order that the resistance of the lengths of the arcs, *h*, *h′*, respectively between the point, *k*, and point, *h*, and point, *k′* and point, *h′* may balance; hence, if the arm, *k*, be set at a certain angle, the observer at arm, *k*, may recognise that angle by noting the position of the arm, *k*, and the galvanometer, as before. It will be observed, however, that the effect of moving the arm, *i*, over arc, *h*, is practically to lengthen or shorten or to interpose more or less resistance in the member, *a*, of the bridge, and by operating the arm, *i′*, a like effect is produced in the member, *b*. The resistances or lengths of the members, *c* and *d*, remain unchanged.

Referring now to fig. 3, there is shown an arrangement which forms the basis of a specific embodiment of the invention, more particularly hereinafter described. In said fig. 3 the arc, *h*, is connected at its respective ends, *j*, J, to the members, *a*, *c*, and the arc, *h′*, is similarly connected at, *j′*, J′, to the members, *b*, *d*. The battery wires connect to the pivots, *l*, *l′*, of the arms, *i*, *i′*, as before. Now, when the arm, *i*, is moved from its middle position on its arc toward *j*, less resistance is caused in the member *a*, and more resistance in member, *c*; and when moved in the opposite direction, the reverse occurs. So, also, a similar effect is produced by moving arm, *i′*; and thus the resistance offered by all four members of the bridge may be affected instead of that due to only two of them, and differential results may be obtained, as will more fully be apparent in the following description of a device for measuring distances, such as a range-finder for guns.

Referring to fig. 4, let T be the position of the object the distance of which from the point, A, it is desired to ascertain. Let A B be any short base-line. Draw A C at right angles to B T, E A parallel to B T, and prolong A T as to D. By trigonometry

$$\left.\begin{array}{l}\mathrm{A\,C} = \mathrm{A\,T}\sin\mathrm{A\,T\,C}\\ \mathrm{A\,T} = \mathrm{A\,C}\operatorname{cosec}\mathrm{A\,T\,C}\end{array}\right\}\text{ and }\left\{\begin{array}{l}\mathrm{A\,C} = \mathrm{A\,B}\sin\mathrm{A\,B\,C},\text{ whence}\\ \mathrm{A\,T} = \mathrm{A\,B}\sin\mathrm{A\,B\,C}\operatorname{cosec}\mathrm{A\,T\,C}.\end{array}\right.$$

A B, being the measured base-line, is known, and the angle A B C at the point of observation is easily determined, so that the angle A T C remains to be found; but A T C = D A E, and D A E is subtended and measured by the arc G H. Arc G H = arc *j* H − arc *j* G, and arc *j* H = arc J′ K: hence arc G H = arc *j′* K − arc *j* G.

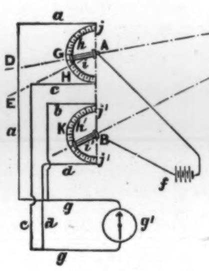

FIG. 5.

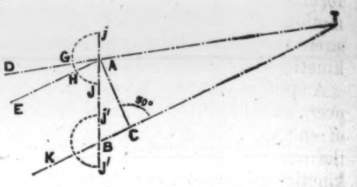

FIG. 4.

In fig. 5 the diagrams figs. 3 and 4 are combined; *i*, *i′*, as before, being swinging arms traversing the arcs, *h*, *h′*, and the connections, *a*, *b*, *c*, *d*, of the bridge being present also, as before. Let the arms *i* and *i′* represent alidade-arms or telescopes, both directed upon the object, T. The arcs, *j* G and *j′* K, not being equal, the bridge will not balance; but when the telescope, *i*, is moved to the line, E, H, then the bridge will balance; but the distance thus moved is the arc, G H, the length of which may be read off from the arc, *h*, itself. It will be seen, therefore, that the operation of determining the distance, A T, becomes, by the aid of this apparatus, exceedingly simple. The observers at the respective telescopes, *i* and *i′*, direct their lines of sight upon the object. The observer at *i* notes the angle, *j*, A, G, or length of arc, *j*, G. He then moves the telescope, *i*, until the galvanometer, *g′*, which may be placed conveniently near his position, shows no deflection, and notes the angle, *j*, A, H, or length of arc, *j*, H. The difference between the arcs, *i*, G, and *j*, H, equals the arc, G, H, whence the angle, A, T, B, and hence the distance, A, T, is found by the observer at the arm, *i*, or, in other words, by an observer at the base line. The disposition of the apparatus whereby an observer at a point distant from said base line may at once read off the distance, A T, from a suitable scale will now be explained.

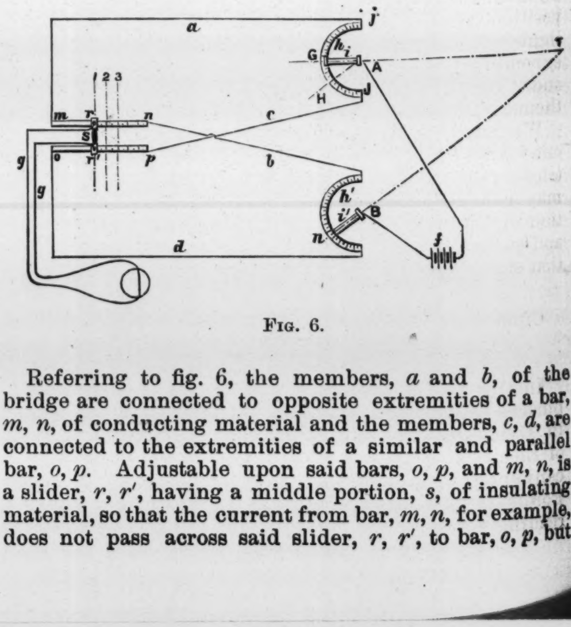

FIG. 6.

Referring to fig. 6, the members, *a* and *b*, of the bridge are connected to opposite extremities of a bar, *m*, *n*, of conducting material and the members, *c*, *d*, are connected to the extremities of a similar and parallel bar, *o*, *p*. Adjustable upon said bars, *o*, *p*, and *m*, *n*, is a slider, *r*, *r′*, having a middle portion, *s*, of insulating material, so that the current from bar, *m*, *n*, for example, does not pass across said slider, *r*, *r′*, to bar, *o*, *p*, but proceeds by the wire, *g*, through the galvanometer, *g″*. Suppose, now, that the telescopes, *i* and *i′*, are sighted upon the distant object, T, as before, and that the slider, *r*, is at the middle point 1 of the parallel bars, *m*, *n*, and *o*, *p*: the resistances in the bridge will obviously not balance. It has already been explained in connection with fig. 5 how, by moving telescope, *i*, to the point, H, the resistances might be balanced; and if that were done, with the arrangement shown in fig. 6, the fact would obviously be indicated by a deflection of the galvanometer-needle; but now let it be assumed that the telescope, *i*, after being sighted upon the object, T, is not moved, or, in other words, that the observers respectively at the two telescopes, *i* and *i′*, simply adjust their instruments in line with T. Obviously, then, the distance of the bridge from *r* to G (member *a*) is less than the distance from *r* to *k* (member *b*) by the length of the arc, G, H. Similarly the distance on the bridge from *r′* to G (member *c*) is greater than the distance from *r′* to *k* (member *d*) by the length of arc, G, H.

Now let the resistance per unit length of the bars, *m*, *n*, *o*, *p*, be made equal to or with some definite relation to the resistance per unit length of the arcs, *h*, *h′*, and lay off on bar, *m*, *n*, a distance, *r* 3, and on bar, *o*, *p*, a distance *r′* 3, said distances being such that the resistance due thereto will be equal to that of the arc, G, H. Clearly, if the end, *r*, of the slider be moved to the position 2 on bar, *m*, *n*, the member *a* will be increased and the member *b* will be diminished by the distance *r′* 2, which offers a resistance equal to one-half that of arc, G, H; and if the end, *r′*, of the slider be moved to the position 2 on bar, *o*, *p*, then the member *c* will be decreased and the member *d* increased by the distance, *r′* 2, which also has a resistance equal to one-half of arc, G, H. As both ends of the slider move simultaneously, it follows that when its extremities are adjusted in the position 2, then the bridge will balance and the galvanometer needle will again be at zero. Applying this practically, let the bars, *m*, *n*, *o*, *p*, be laid off in suitable scale divisions from *r* to *n* and *i′* to *p*. The two telescopes, *i* and *i′*, being sighted on the object, the distant observer watches the needle, and moves the slider, *r*, *r′*, along the bars, *m*, *n*, *o*, *p*, until it returns to zero. The scale marked on the bars then shows an indication corresponding to the length of arc, G, H, or, if desired, actual distances corresponding to such indications.

If the object be moving, the operation of determining its distance is as easy as though it were stationary, and the indications are instantaneous and continuous. With a 290-foot base-line on board the *Chicago*, one instrument being mounted in the bow and one in the stern, the average error in the official trial before a board of electrical and gunnery experts was less than six-tenths of one per cent. The set of instruments about being sent to the *Baltimore* is expected to give still more accurate results.

INTRODUCTION OF ELECTRIC LIGHTING IN BUDA-PEST.

[FROM A CORRESPONDENT.]

THE Buda-Pest papers publish a report on the declaration of the local gas company, with respect to the introduction of the electric light in Buda-Pest, and it may interest your readers to see how gas companies understand the promoting their own interests whilst seemingly meeting the wishes of the public. The report runs:—

It is well-known that the gas company, in accordance with a request of the municipality, has made known the conditions under which it would be prepared to introduce the electric light, and at the same time furnish gratuitously the gas required for street lighting, and reduce the price for the gas required for private consumption. Their conditions have been submitted to the examination of the chief municipal accountant, Lampl, whose reports, as laid before the Deputy-Mayor Gerloczy, may be summed up as follows:—

1. The offer to reduce the price of gas for private consumption would represent an economy of 76,425 florins in the first year, and which by the 16th year would rise to 280,950 florins. But as the private consumption may increase more than it has been assumed, the lowest limit of price should be fixed, not at 11 kreuzers per cubic metre, but lower.

2. The gratuitous supply of gas for street lighting is made by the company to depend on the municipality renouncing the share in the profits which is due to it under a clause of the present agreement. According to the calculations of the accountant, the free street lighting would amount to a yearly economy of 153,575 florins against which the renunciation of a share in the profits would be equal to a loss of 83,109 florins, so that the actual economy in this case only comes to 70,466 florins. The accountant is of opinion that in the case that the net profits of the company, in spite of the free supply for the streets and the reduced figure for private consumption, should exceed the present amount, the Municipality should participate in this excess, as before.

3. As regards the electric lighting, the company demands an exclusive concession for the first ten years only, and after that merely the preference as against competitors who offer identical terms, whilst after the lapse of 50 years the conductions will pass at once gratuitously into the hands of the Municipality. These conditions, the accountant thinks, may be accepted on the following conditions: (*a*) That the right of the Municipality to undertake a release is properly secured; (*b*) That the Municipality must be entitled, but not bound to a release; (*c*) That the price of a release shall be determined not by a law court, but in the manner stipulated in the present gas agreement; (*d*) That the price of release before the expiry of the term of the concession shall be fixed by a valuation; (*e*) That the demand that in case of a possible dissolution of the gas agreement the electric works shall be given up according to the wish of the company, must be declined.

4. For the electric light a price is demanded of 5⅔ kreuzers per 100 volt-ampères. But as this price refers to a measurement of the electrical constants, and not to the strength of the light, the accountant considers that the number and the illuminating power of the lamps should serve as a basis. A price of 5⅔ kreuzers per 100 volt-ampères corresponds for a light of 14 candles to a price of 98 florins $22\frac{43}{100}$ kreuzers yearly for the entire night, or 53 florins $17\frac{3}{100}$ kreuzers for a half night, whilst a 14 candle gas-flame, according to the present agreement, costs yearly for the whole night 39 florins 61 kreuzers, and for the half night 20 florins 68 kreuzers. Thus under otherwise equal conditions an electric lamp for the whole night will be 58 florins 62 kreuzers dearer, and one for the half night 20 florins 68 kreuzers dearer than a corresponding gas-flame. To illustrate these figures it is mentioned that up to the end of the year 1888 the number of lamps for the entire night was 3,577, and those for the half night 3,746. Accordingly the yearly cost of lighting amounts to 219,152 florins 25 kreuzers, but in case of the universal adoption of the electric light it would amount to 550,507 florins 76 kreuzers. That is, under equal conditions the electric lighting of the streets would cost two and a half times more than gas lighting, assuming for the sake of comparison that glow lamps were adopted.

The accountant computes the price of the electric light for private consumers at 58 florins 54 kreuzers yearly, whilst a gas-burner of the same illuminating power at the present high price of 12¾ kreuzers per cubic metre is estimated only at 35 florins 95 kreuzers, but at a price of 11 kreuzers only at 31 florins 7 kreuzers.

Hence, the accountant concludes from a careful examination of the proposal, leading to the result that, especially as regards the electric light, the offer can be accepted only with great additions and modifications. It is therefore suggested that negotiations with the gas company should be at once commenced according to point 4 of the agreement, which has been concluded with it for 14 years up to December 15th, 1895, inclusive, and continued without interruption. In case an agreement cannot be arrived at then, as far as the electric light is concerned, negotiations shall be commenced with other contractors, and if this does not lead to the desired result the steps to be taken after the expiry of the agreement are at once to be arranged.

INTERNATIONAL MINING EXHIBITION.

AN International Exhibition of Mining and Metallurgy will be held at the Crystal Palace, Sydenham, during the summer of this year. The exhibits will include electricity in its application to mining and metallurgy, electrical haulage, the electric lighting of mines, electrical transmission of power, electrical extraction processes, telpherage, &c., explosives, the transport and shipment of minerals, mining tools and appliances, &c., &c. The exhibition will be on an extensive scale, and every endeavour is being made to render real practical service to those engaged in the various branches of the trades concerned. Steam and gas engine power will be available at moderate rates, and the general charge for space will be 2s. 6d. per square foot of floor space, except in a few special positions, and 1s. 6d. per square foot of wall space. During the holding of the exhibition, which will be opened on the 2nd July, and close on the 30th September, it is proposed to establish a series of technical and popular lectures on subjects connected with the exhibition, and also to hold a mining congress during the period of the exhibition.

Those electrical firms who have recently paid attention to the practical application of electricity to mining and metallurgical purposes might find it advantageous to participate in this exhibition. Only recently, it will be remembered, the representative of an American electrical company obtained, in London, an order for the supply of several Sprague electric motors and other apparatus for use in one of the South African mines. English electrical companies might easily hold their own against their rivals, and one way to do this at present is by their taking part in the forthcoming exhibition. Applications for space are to be sent to the hon. secretary, at the offices, 18, Finch Lane, E.C., not later than 15th March, and from whom further information may be obtained.

THE SERIES TRACTION SYSTEM.

IT will be remembered that in March, last year, a short electric tramway, three-quarters of a mile in length, on the "series" underground system, was inaugurated at Northfleet by the Series Electrical Traction Syndicate, Limited. The line is the only electric tramway in Europe where this system has been adopted and worked, and the object of the syndicate was to show that the series principle could be made practicable in this country, and to work the system generally. On the Northfleet line only two cars were placed upon the track, which presented some severe gradients; but, owing to the small number of passengers requiring to be carried in that locality, which is rather rural, one car is at present capable of performing the service, with the exception of on busy days when both cars are run. The tramway is worked under several disadvantages. In the first place, it is very short, with only one car usually running; and, besides the rental which the syndicate pays for the use of the line, heavy taxes have also to be paid. In addition to this, as a certain number of the passengers carried are transferred from the horse cars at the tramway depôt, only a percentage of the receipts from these is handed over to the syndicate. It will be evident from these disadvantages that the line can scarcely be expected to have turned out financially successful; in fact, the peculiar conditions of the line in question are such that the company never anticipated making it a paying concern. What they expected to do was to prove by this experimental line that the series system could be practically worked, and this they claim to have demonstrated after nearly a year's continuous running.

We are informed that since the opening of the line there has not been a breakdown in the service, but this is not the experience of passengers we have known to travel on the line; however, the cars have been run on one occasion when the snow lay so thick upon the ground that it was found impossible to work the horse cars, whilst after a heavy fall of rain which caused the conduit to half fill with water, the service was still maintained. Mr. E. Bergholt, the secretary of the syndicate, estimates from figures compiled from the actual working expenses of the line that the cost per car mile on a longer tramway, with, say, half a dozen cars, would be less than 3d., but we are unable to give any details. The Series Syndicate has obtained contracts for the working of no less than six provincial tramways by electricity, including that of the North-Western and Midland District Auxiliary Railway Company, and which will be 7¼ miles long. The work will either be carried out by the syndicate or by another competent company, possibly by the gigantic combination which is shortly to take place, and to which we referred two or three weeks ago.

The series and battery systems of electric traction are at present in the following positions :—

IN OPERATION.

Series System.	Miles.	Battery System.	Miles.
Northfleet	¾	Barking	1¼

PROJECTED.

Series System.	Miles.	Battery System.	Miles.
North-Western and Midland District Auxiliary Rail. ...	7¼	Birmingham Tramways Company ...	—
Wellingborough and District Tramroads	2½	London Tramways Company	—
Five other lines, names not ascertained...	15	South London Tramway Company ...	—
		North Metropolitan Tramway Co. (extensions of present system) ...	—

THE ALTERNATING CURRENT TRANSFORMER SYSTEM IN ITALY.

(FROM A CORRESPONDENT.)

RARELY has the electric lighting of towns made in any country such rapid progress as in Italy. The reason of this is easily intelligible from the circumstance that there, as in all southern countries, a nocturnal life is very prominent, which involves an urgent need for abundant lighting. Moreover, the rise of electric works for lighting purposes is greatly assisted by the many and copious sources of water-power which in Italy are available for industrial purposes. As such water-power is generally at some distance from the centre of the towns the use of the transformer system as the method *par excellence* of conveying electric power to a distance becomes a necessity. But even in towns where the electrical works are actuated by steam power the need of conveyance to a distance is experienced. In Italy, where large industries have not made such progress as in those European countries more engaged in manufactures, the disagreeable features of steam operations in the more populous quarters of a city are more strongly felt than in cities where factories are plentiful. Hence there is a wish to place electrical works, if possible, in the outskirts of the towns or, preferably in the open country.

The most imposing installation of transformers in Italy, and unquestionably one of the most extensive which exists at present, is that of the gas company of

Rome, which includes two alternating current machines of 150 H.P. each and four of 600 H.P. each. To this central net there were connected up to December 31st, 1889, 120 transformers of 7,500 watts capacity each, which feed the following lamps :—

1,438 Edison lamps of 10 normal candles each.
5,765 „ „ 16 „ „
123 „ „ 32 „ „
56 „ „ 50 „ „
14 arc lamps of 8 ampères current.
270 „ „ 16 „ „
14 „ „ 32 „ „

Both the primary and the secondary conductive net consists of underground concentric cables sheathed in iron, and of the following dimensions :—

Primary Net.

8,348 cable metre run with 2 × 220 sq. mm. section of copper.
3,459 „ „ 2 × 50 „ „
2,815 „ „ 2 × 50 „ „
338 „ „ 2 × 12 „ „

Secondary Net.

638 cable metre run with 2 × 220 sq. mm. section of copper.
599 „ „ 2 × 50 „ „
482 „ „ 2 × 25 „ „
320 „ „ 2 × 12 „ „
737 „ „ 2 × 6 „ „

As a supplement to this central station the Roman Gas Company is erecting large electrical works at Tivoli, concerning which you have already published certain information, and I hope soon to furnish interesting details on this really magnificent installations, which convey 1,700 hydraulic H.P. to a distance of 30 kilometres.

The Milanese Edison Company displays also great activity in the application of alternating current transformers, and has already carried out 11 installations for the electric lighting of towns on this system. At present the company is putting up a very interesting installation of transformers for lighting Venice. In the first place, with two alternating current machines, each of 80,000 watts (40 ampères and 2,000 volts), but a considerable extension will soon follow.

The accompanying table gives a list of the Italian central stations, which have been already constructed with alternating current transformers, or which are in the course of erection :—

Place.	Motive Power.	System.	Capacity in Watts.
Tivoli	Water Power.	Gaulard.	6,000
Milan	Steam	Zipernowsky, Deri and Blathy.	150,000
Rome	„	„ „	1,440,000
Turin	„	„ „	300,000
Bagni di Lucca	Water	„ „	15,000
Treviso ...	„	„ „	60,000
Terni	„	„ „	240,000
Palermo ...	?	„ „	40,000
Lonato ...	?	Rivolta and Co.	?
Livorno ...	Steam	Zipernowsky, Deri and Blathy.	240,000
Taglicozzo ...	Water	„ „	15,000
Perdehohe ...	„	„ „	30,000
Bassano ...	„	„ „	50,000
Syracuse ...	Steam	„ „	150,000
Cimeo	?	„ „	150,000
Schio	Water	Oerlikon-Kapp	50,000
Alzano Maggiore	„	Zipernowsky, Deri and Blathy.	100,000
Rome-Tivoli ...	„	„ „	800,000
Venice ...	Steam	„ „	160,000

The installation at Schio, which has been constructed by the Oerlikon Company with Kapp's alternating current machines and transformers, is interesting, because the entire private lighting with 420 glow lamps of various illuminating power (10, 15 and 25 normal candles), is supplied from a single transformer placed at the centre of the conductive net.

As regards the Gaulard installation at Tivoli, and that fitted up at Lonato, by Gazzi, Rowizza & Co., of Milan (in the table the name given is Rivolta & Co.), it must be remarked that the transformers are introduced in series.

THE INFLUENCE OF TEMPERATURE UPON THE VARIATION OF BISMUTH IN THE MAGNETIC FIELD.

FROM 1884 to 1886, writes M. A. Leduc (*Comptes Rendus*), I made a study of the augmentation of the electrical resistance of bismuth in the magnetic field, and demonstrated that the augmentation, Z, of the unit of resistance in the field of intensity, M, was connected with the latter by the equation

$$Z^2 + \beta Z - \alpha M^2 = 0.$$

The parameters α and β of this hyperbola depend upon the sample experimented with.

The measurements were taken in a temperature which varied very little while the experiment lasted, but which might vary greatly between morning and evening, and especially from day to day, according to the season of the year. I had imagined, wrongly as we shall presently see, that the phenomena were not affected by the temperature. Let me hasten to add that the general results were none the less obtained. A few figures only need to be slightly modified ; for the others we shall have occasion to particularise as regards the temperature at which they were obtained.

Some divergencies between observations made in February, 1886, and again in July, 1887, in respect of the same sample, induced me to think that this phenomenon, like that of Hall's, was apt to vary with the temperature ; and this, in fact, was said to be the case by M. Van Aubel in 1888. It was only recently that I had an opportunity for resuming my investigations in regard to it, and I shall now proceed to state the first results which I obtained.

The bismuth (electrolytic deposit) having been attached to ebonite by means of gum-lac and wax, was placed in a narrow vat into which were placed ice in a melting condition, then water at 16°, 30°, and 45°, successively.

The magnetic field scarcely overstepped 9,000 C.G.S.

As regards each of these temperatures, the curve of variation of Z in relation to M is properly expressed by the equation (I) ; but α and β are variable with the temperature.

The ratio $\frac{Z_t}{Z_o}$ of the values of Z to t^o and to 0^o in respect of the same magnetic field, appeared to me to be independent of the value of the latter. This certainly should be the case supposing the equation (I) to express the phenomenon strictly, as I have taken it to do, and not approximately.

If such is the case, the real axis of the hyperbola $\left(b = \frac{\beta}{2}\right)$ alone varies with the temperature, and the suppostitious axis $\left(a = \frac{\beta}{2\sqrt{a}}\right)$ simply depends upon the peculiar qualities of the sample experimented with : this I shall attempt to verify by numerous experiments made with different samples, and as much as possible under the most varying conditions of temperature. In any case with $M = 7{,}000$ C.G.S. the variation of Z is properly expressed between 0° and 45° by the following formula :—

$$Z_t = Z_o\,(1 - 0{\cdot}0109\ t + 0{\cdot}000035\ t^2)$$

This formula shows that in the neighbourhood of 15° Z diminishes at the rate of 1 per 100° centigrade.

LIGHTING OF "LE HOCHE."

WE give here a few particulars of the plant fitted up on *Le Hoche*, a French cruiser of the first class, recently despatched on its trial trip of machinery. There are four groups of Desroziers dynamos, each capable of giving 200 ampères at 70 volts pressure whilst running at 350 revolutions, and the engines are compound, of the Breguet type. The consumption of steam per horse power hour measured on the brake is 24 lbs., which figure has been obtained on a six hours' test made by a special commission. The number of revolutions is controlled by a speed regulator between 345 and 355 turns, whilst the lubrication is effected automatically, all parts being easily accessible. The engines are attached to the dynamos by the now well-known Raffard coupling, consisting of two plates united by indiarubber rings. The vessel is provided with two distributing boards, both being alike and each capable of being used at any moment. One board only will be employed, the other being ready for use in case of damage to the first. On each is fixed a Breguet voltmeter without magnet, four Carpentier ammeters, 17 four-way commutators corresponding to the four dynamos, and 17 principal double cut-outs. The conductors are throughout let in wood and are readily accessible. There are installed six projectors of 60 centimetres provided each with an arc lamp taking from 65 to 75 ampères, the lighting power of which is equal to 3,000 gas jets. The exterior lighting comprises 14 50-C.P. and 23 32-C.P. incandescent lamps, and the interior, 350 lamps of 10 C.P. In the exterior lighting the signals are comprised of 32 C.P. lamps fixed along the backstays, which are hoisted at the desired moment to the top of one of the main masts. The current to these lamps first passes through the manipulator, an apparatus for preparing, executing, reading and extinguishing the signals. The route, position, towing, &c., lamps are of 32 C.P., and are contained in regulating lanterns, whilst two reflectors are provided for illuminating the bridge during night manœuvres, each being composed of a group of seven 50 C.P. lamps which can be fixed in any desired place on the main bridge. Trials of the electrical plant took place recently at L'Orient for 27 consecutive hours, and the results obtained were satisfactory.

THE HALLES-CENTRALES.

AT a recent meeting of the *Société Internationale des Electriciens*, M. F. Meyer made some interesting statements regarding the recently established factory for electricity at the Halles-Centrales, Paris. This, it will be remembered, is the first attempt made by the *Ville de Paris* to supply electricity direct to the consumer. The engineers in the service of the Municipality regard it, therefore, as a point of honour to make the establishment as complete as it can be, by means of the latest improvements in electrical plant which may from time to time come into existence.

M. Meyer reminded his hearers that in supplying electricity to any considerable distance it is necessary, for the sake of economy and convenience, to employ high tensions. The scheme submitted by the Municipality is divided into two distinct groups of low and high tension machines, each giving about 250,000 watts The low tension service, the only one at present in use, is carried on by means of three Weyher and Richemond vertical triple expansion engines of 150 H.P. Each of these machines is responsible for the working of two dynamos of the Edison Continental Company, furnishing 450 ampères and 115 volts at the terminals. For the high tension service three Corliss engines of 170 H.P. will be employed, each to drive a Ferranti dynamo furnishing 46 ampères to 2,400 volts at the terminals.

The most interesting portion of the system, according to M. Meyer, is that connected with the coupling of the dynamos. The apparatus is the invention of the general secretary and consulting engineer to the Edison Company. It has made it impossible to put a machine either in or out of circuit until all the necessary precautions have been taken automatically for creating or suppressing the excitation in the dynamos. Lamps of various types are employed in order to enable a definite choice to be made between them. The only point which has given rise to anxiety has been the necessity for taking down and reinstating the lamps when the carbons have to be changed, which sometimes occurs twice daily owing to the extension of the hours of lighting in winter, and the result of which has been the rapid wearing out of the conductor wires by the friction they undergo from the rollers. As regards the means to be employed in the distribution of electricity the engineers have made a close investigation of the different systems in vogue in France and abroad. Upon their choice, as M. Meyer pointed out, depends, in fact, the whole question of economy in the service; but it is not, he adds, under this head that it has been thought advisable to economise. The low tension cables have been furnished by the Maison Menier and the India-Rubber Company; their insulation is effected by means of pure rubber, and again by vulcanised rubber, and a final envelope composed of a double ribbon and braid, and thus they are calculated to offer an insulation resistance of 300 Ω per kilometre. The canalisation is effected by means of cables enveloped in rubber and resting on supports of vitrified iron; these latter are screwed into wooden frames which are laid in conduits of moulded concrete; thus it is intended to secure a three-fold insulation. The conduits being closed by means of clay, may be easily opened as occasion requires. The advantages of the method of insulation adopted have, according to M. Meyer, been proved by the frequent testing it has undergone. He pointed out that the system of low tension distribution involved one drawback only, viz., the breadth of space occupied by the conduit and the complications inseparable from the number of cables necessitated wherever feeders are employed. In spite of this, the Municipality has been able to limit the space taken up by its conduit to 0 m. 50. As regards the high tension system, on the single occasion of its employment, viz., the inauguration of the factory, its working was altogether satisfactory for exterior distribution. The canalisation will be effected by conduits in cement considerably smaller than those employed for the low tension. Extraordinary precautions have been taken to secure absolute safety with a pressure of 2,400 volts. The cables have been supplied by the Société Generale des Telephones; the thickness of the rubber envelope has been designedly exaggerated. and are calculated to offer an insulation resistance of 3,000 Ω per kilometre. The cables will be enclosed in wood mouldings, these latter being placed in conduits, so as to secure an envelope of triple impermeability. The transformers, essential to a system of alternating currents, will be placed at the entrance of houses, so as to reduce as much as possible the portion of primary canalisation allotted to the consumer, the primary wire being always a source of anxiety whatever the precautions taken. The municipality now spends something like 500 frs. per hour, not including the cost of reparation of material, this being entirely new; nor does this include rent, water supply, nor the sinking fund, but it includes the renovation of the arc carbons and the wages of workmen employed in this operation, items which are not exactly proper to the factory. On the other hand, the duration of production amounts to 1,300 kilowatt hours, which raises the cost of the hectowatt hour to 0 fr. 4 c. for expenses proper to the factory—*e.g.*, carbon, oil, salaries, &c. But, adds M. Meyer, when for every three of the present subscribers the municipality has secured thirty or forty, the receipts will be greatly increased, while the expenditure will have undergone no change, since the machines, in lieu of being worked at a demi-charge, will be working at the rate of four-fifths or five-sixths.

OPERATION OF ELECTRIC MOTORS WITH HIGH TENSION CURRENTS.*

By ELMER A. SPERRY.

THE recent advance in the transmission of power by electricity in this country and abroad, and its adoption on a more or less extensive scale for the utilisation of distant water powers in the mining districts, indicate that the state of the art has reached that point where it has ceased to be an experiment, and where the most direct methods and the betterment of the various details of construction are matters of paramount importance. The present widespread interest in high tension currents, and the discussion in connection with their use in the distribution of electricity for electric lighting, lead me to the few remarks which follow, hoping to direct attention to their employment in the transmission of power, that this field for the use of high tension currents may not be neglected, and may also receive whatever benefit may result from the general discussion now in progress.

For the transmission of power from one point to another there can be no question as to the utility and great advantage of employing high potentials. I speak, now, of the transfer of power from one point to another as contra-distinguished from the distribution of power for domestic or like purposes on a widespread scale. I, however, see no reason why in the near future, this latter system also should not be prosecuted along the lines of high tension currents, inasmuch as the phenomenal progress which has characterised electrical engineering enterprises in the past will bring the question of insulation to a point where danger to life and property will almost entirely cease to be an element to be considered. This will doubtless be brought about, too, by the utilisation of safety devices in the central plant, as well as throughout the construction.

In the consideration of high potentials as applied to the transmission of power, I propose to take a practical instance and carry it out along the line of each of the two foremost plans known to electrical engineers, namely, first by constant current, and second by constant potential, hoping by this means to point out the principal differences and ascertain, if possible, which is the better, cheaper, and more desirable method.

Before starting with the examples, it is desirable to settle the fact that the work of each of the plants shall be satisfactory in so far as practical operation is concerned.

This will depend upon economy and regulation. We will assume, so far as the practical operation is concerned, that with shunt, compounded, or over-compounded generators, and with shunt or compound-wound motors, the matter of regulation may be satisfactorily worked out. But can the regulation be equally well maintained upon the constant current plan?

It will be granted by all who have investigated the matter that constant current generators can be regulated automatically, as to their potential, from zero to full load, in response to demands thereon for work, and this is done in a satisfactory manner.

But referring to the motor, the argument urged against the constant current method is that the field coils, each have to be divided into a great many parts, each of these parts led to sections of a stationary commutator, and contacts driven backward and forward over this commutator by means of the centrifugal force of the varying speed tendencies of the motor. That the potential difference of a constant current motor may be made to meet the varying demands thereon for work, has been demonstrated. But it has been further demonstrated, that the method of simply rotating the brushes about the commutator, between the points of zero and maximum potential difference, in a constant current motor, may be satisfactorily employed to regulate the electrical energy absorbed.

The problem here is to obtain a sparkless commutator. This has received its solution and the mathematics of the various functions is known, and holds equally in motors or generators of any size. Furthermore, the sparkless region for varying currents has been broadened out until it is made to comprehend a variation of 50 per cent. of the normal current either side of the normal current point. By this is meant: Suppose the normal current to be 40 ampères, then there is a region of 20 ampères lying half each side of the 40 ampère mark through which range the commutator is entirely sparkless. This seems to me to be by far the simplest way by which to adjust a constant current motor. Various devices may be employed to accomplish the mechanical rotation of the brushes in response to varying speed-tendencies, but that which will recommend itself as being the best is the one in which the varying centrifugal forces are called upon to do the least amount of mechanical work. These forces are not great until the speed differences are great, hence for close regulation they should be called upon to perform only functions involving light duty; for instance, calling into action mechanical forces which in and of themselves perform the ultimate duty of rocking the brushes, especially in heavy machinery where these elements are more or less large and ponderous.

The question may be asked: Can centrifugal force ever be employed to hold the motor within the same speed limits as shunt or compound winding? I answer, it can. There is no reason why the same degree of perfection should not be attained in this as in steam engineering. There are steam engine builders who will contract to hold the speed within 1½ per cent. from full load to zero. No better result than this need be desired in any motor.

Electrical science has advanced so rapidly and the theories have changed so radically that statements put forward but comparatively a few years ago naming impossibilities in the art have been often exhumed in the present day as marks of advancement. Writers on dynamo machinery are so modern that, profiting by the errors made by former writers upon other subjects, they have been rather wary in pointing out impossibilities. But sweeping assertions must be made, and writers who are considered as high authorities have pointed out the impossibility of making a sparkless commutator under the conditions named above. Since it now has become an accomplished fact, it may be said that doubtless these statements denying the possibility of results of great importance are useful as incentives to those working along the line, who do not agree with the author.

There is, however, one point with regard to a sparkless commutator, under conditions of constant current, which I wish to point out, namely:—That from the maximum to the minimum point of potential the brush must always be handled in the direction it points from the former point toward the latter, and not in the opposite direction. The distribution of potentials about a commutator is shown in fig. 1. From this figure it will be seen that the distribution is equal on either side of the maximum line, and there seems, on the face, no reason why the brushes should not reduce the potential if rotated in either direction from the maximum point. Either toward the left or toward the right the minimum point, or position, B or B′. While the brushes, in their movement to the left are perfectly non-sparking, if attempt is made to move them in the opposite direction to position, B′, they spark seriously. No reason for this has been put forth to my knowledge. The following is offered as a possible explanation of this phenomenon:—Allow fig. 2 to represent either a dynamo or motor, with commutator at centre, and armature cord disposed between N, N, the north pole pieces, and S, S, the south pole pieces; *t*, *t*, *t* and *f*, *f*, *f* show the windings; *n* indicates the polar axis of the armature. When this armature is used as a generator it will rotate in the direction of arrow, G, and when used as a motor it will rotate in the direction of arrow, M. The small arrows, under the pole pieces, indicate the direction of the lines of force to or from the armature core. Suppose the system to be operated as a generator, and the brushes to be rotated over towards the right, the polar line, *n*, or the pole in the armature, will be held by the overmastering magnetism of the pole pieces to a position which constantly tends to be back of or toward the left of the brush contact, thus leaving the brushes among the coils, *f*, *f*, *f*. The current in these coils is in the direction going from the

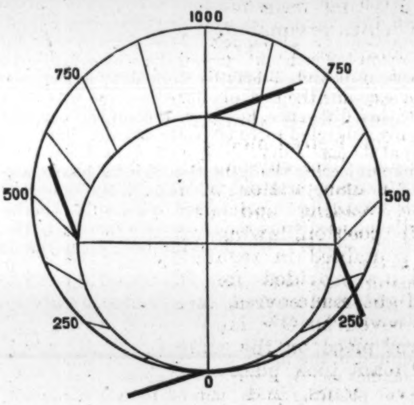

FIG. 1.

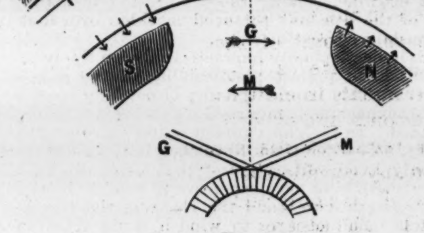

FIG 2.

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* Read before the Chicago Electric Club, February 3rd, 1890.

observer, and hence is antagonistic, if the expression be permissible, to the direction of the lines of force emanating from the poles, N, N, therefore there is no tendency to the development of abnormal electromotive forces between the adjacent coils. However, if the brushes be rotated to the left the displacement, or the drawing of the polar line, *n*, by the south pole, and its being repelled by the N, N, will still keep it to the left of the commutator brush contact. As soon as the windings, *f*, *f*, *f*, come within the range of the pole pieces, S, their current direction is in harmony with the direction of the lines of force into the pole pieces, S, S, thus giving an exaggerated value to the potential developed in adjacent coils. These coils being directly under the contact of the brush develop local currents acting through the brushes producing the tremendous sparking observed.

When the system is used as a motor, and is revolved in the direction of the brushes and arrow, M, the converse of this law operates, inasmuch as the polar displacement is reversed which would require, as is found in practice, that the brushes, M, should be rotated to the left for non-sparking instead of to the right as in the case of the generator.

To proceed with the example. Let us take a transmission of 50 horse-power, three miles distant, upon a circuit of 31,680 feet. Place the total economy of transmission at the low figure of 66 per cent., which will be distributed 14 per cent. each in dynamo and motor, and 5 per cent. in the line. We will adopt as potential 3,000 volts; transmissions are used twenty-four hours a day with this voltage as well as scores of arc light dynamos with no practical inconvenience. This voltage would give about 18·7 ampères in the constant current distribution. Let us assume that a constant potential may be worked upon the same voltage. Now let us examine the two plants. The line wires are the same size; with this difference, however, that in the constant current they are only subjected to 3,000 volts at such times as the plant is working at its maximum; during all other times the voltage is below, thus subjecting the insulation to a far less strain with less liability of breaking it down; whereas, in the constant potential system this 3,000 volts is maintained constantly whether there is any power being used from the motor or not, even if the motor is driving itself solely. The heavy stress upon the insulation, therefore, is constant.

The armatures are practically the same, because for the same speed and same field intensities, the number of convolutions and sizes of wire will be equal.

Let us examine the fields. Taking 3 per cent. of the total energy required in the fields, we have in the field of the constant current machines merely a series wire measuring 10,000 feet with a difference of potential at its ends of 100 volts, running 100 feet to the volt, being a large wire easily handled and one that will withstand shocks, jars and rough handling indefinitely. Taking the same number of square mils per ampère for the wire in the field of the constant potential machines, we find that an extremely small wire has to be employed. We find that this wire must be 62 miles in length; we find that the difference of potential between each successive layer upon the fields is 200 times that which exists in the constant current fields, taking at least forty times as long to wind the same. This great increase of potential difference between the successive layers should require double covered wire. Let us see what bearing this has upon the case. With double covered wire of this size the ratio of insulation to copper would be 44 per cent., whereas in the constant current the ratio of insulation to copper is only about 3 per cent. This requires about 40 per cent. more field space in the case of the constant potential, which means a larger machine as compared with the constant current generator. The actual net cost, pound for pound, of wires in this instance would be 3½ times as great in the constant potential as in the constant current machine, making the total cost of insulating wire for the field of the constant potential machine over four times that of the constant current machine.

These details indicate plainly impracticability on the part of the constant potential and perfect practicability in the case of the constant current. This impracticability is not decreased as the complexity of the machine is increased by being compounded or over-compounded. In fact, an eminent writer on constant potential machinery, no earlier than November last, in discussing a pressure of only 1,000 volts, states "that where high pressure generators are used it is very expensive to wind a shunt field of high enough resistance to stand the electromotive forces of the armature. It is much cheaper to wind a shunt field for low pressure, say of 110 volts, and separately excite it by a small constant potential dynamo." This, of course, would add to the plant another item of expense which would be slightly more expensive, though far more practicable than the field winding described above on the 3,000 volt basis.

In the practical operation of constant potential motors the use of an artificial resistance is imperative, by means of which the lack of counter electromotive force in the armature of the motor, as the speed starts and increases to the normal, is made up by dead resistance. This resistance for large motors occupies much space, and in case of high potentials is expensive. In the constant current plant, however, a switch shunting the motor is opened, and there is at once thrown upon the motor only its normal amount of current, and as the same starts and its counter electromotive force increases, the electromotive force of the generator also increases in proportion, until its normal speed is reached, without at any time any increase of current whatsoever or tendency to burn. On the other hand, with the constant potential, should an accident happen and the machinery be brought to a stand suddenly, there is serious danger of overheating and burning the coils of the armature and series coils of the fields. In this emergency the constant current is cared for automatically by the regulator on the generator, which diminishes the potential upon the line, correcting the current intensities almost instantaneously. Upon both constant potential motor and generator, as the load increases and diminishes, a manual adjustment is also required to keep the brushes on the non-sparking point.

It is found in practice that if constant potential motors, as ordinarily constructed and connected in circuit, are belted to the same shaft or otherwise connected to the same work, so that they must revolve together, the result obtained is unsatisfactory, because of the fact that the load will be unequal and disproportionally divided. This is due to the fact that it is impossible to construct two electric motors, the armatures of which shall have precisely the same counter electromotive forces, therefore if two motors coupled together in this way are supplied from the same main the armature which produces the lowest counter-electromotive force will take a larger current than the other motor. The effect of this increased flow is to greatly exaggerate and enhance the difference existing between the motors, because the fields of the motors are disturbed by the increased flow and its counter-electromotive force is still further reduced, resulting ultimately in burning or destroying one of the motors.

Prof. Rice has recently devised a system to overcome this effect, but at best it is complicated, and still further increases the complexity of the machine. Another way would be to run each motor connected to a separate generator with separate line wires, but this, to say the least, is expensive. Any number of constant current motors may be attached to the same power; in this case their regulators are dissimultaneously operating. Having thus pointed out some of the differences, let us look into the stations provided with these two sets of apparatus. In the constant potential generating station we find a very large machine. Upon the wall are an ammeter, a voltmeter, a large rheostat for controlling the fields, and most probably an exciter and duplicate set of station instruments. Connected with the exciter, at the motor end of this line, we find the motor, a large rheostat and probably another exciter. Going over now to the generating station of the constant current machine, we find an automatic generator which is smaller than the constant potential machine. On the wall we simply find an ammeter. At the motor station we find a motor supplied with a small and durable mechanical regulator for its fields or preferably for its brushes, and perhaps an ammeter upon the wall. This constitutes the entire plant; nothing about it but what can be easily comprehended and successfully operated by an engineer of ordinary intelligence, and we observe an entire absence of complexity of connections in the machines, or circuits running back and forth from the machine to the various devices upon the switch-board or wall; and the first cost and cost of installation of these various devices is decidedly in favour of the constant current system.

It may be said that some of the objections above will be eliminated by reducing the E.M.F. of the constant potential plant. Let us reduce it one-half, that is, to 1,500 volts. Now, it is true that the fields are less difficult to wind, the length of the wire is less and the wire somewhat larger, enough so, perhaps, to do away with the necessity of an exciter. An increase, however, will have to be made in the size of wire on the exterior circuit. The current is now increased to 37½ ampères, and for the same loss in the exterior circuit the wire will have to weigh 14,000 pounds instead of 4,000, costing $2,800 in place of $800; and if the potential is still further reduced to 1,000 volts, in which case there would be 56¼ ampères, the wire would weigh 18 tons and cost $7,200, as compared with $800, for the constant current plant, with poles in the former, at much less intervals and heavier construction all through.

It is hoped that free discussion will be had upon these points, and that additional facts may be developed which will aid in arriving at the most direct method of distributing power electrically.

REVIEWS.

Traité des Piles Electriques, Piles Hydro-Electriques, Accumulateurs, Piles Thermo-Electriques et Pyro-Electriques. By DONATO TOMMASI. Paris: Georges Carré, 58, Rue Saint André des Arts.

Much has been written and much experimental work done with reference to primary batteries, but it must be confessed that the practical results arrived at are very far from being commensurate with the time and money which have been expended in groping about for new combinations of metals and fluids which would enable a steady and powerful electric current to be produced at a very small cost. The subject is, however, undoubtedly a fascinating one, and unfortunately it is also one which unscrupulous speculators have more than once made the most of in order to fill their pockets at the expense of the too easily gulled public. We do not mean to insinuate, however, that much honest work in the matter of primary batteries has not been done, for we can point to more than one example of means attained where extravagant pretentions have not been put forward in order to unduly and dishonestly press claims which are scientifically absurd.

It behoves all who are working at primary batteries to know what has been previously done in the matter, and to all such we can heartily recommend M. Tommasi's work on the subject. We have more than once commented on the author's faculty of hunting up almost endless sources of information, and in the present case he has again brought this faculty to bear with great advantage. It must not be thought that the treatise can be considered absolutely a complete one, but it leaves but comparatively little to criticise on the score of want of fulness as regards descriptions of the various kinds of combinations which have been devised. We have, however, but very little said with reference to the sustaining powers and economies of the different cells; this, however, is not very surprising, as there are but very few inventors of batteries who seem to have any notion of how to test them, being content to state the E.M.F. on open circuit, and perhaps to say that it has rung an electric bell (whose resistance is not stated) continuously for a certain number of hours.

Leçons sur L'Electricité (Electrostatique, Pile, Electricité Atmospherique). By H. PELLAT. Paris: Georges Carré, 58, Rue Saint André des Arts.

This volume contains the lessons which were given by the author at the Sorbonne in 1888-1889.

As book after book of very nearly the same nature is poured out of the Press without cessation, we begin to wonder when this sort of thing is going to stop. We cannot reasonably say that the work before us is deserving of severe criticism, neither can we say that it is deserving of great praise; the book is undoubtedly good and possesses novel points, but beyond this we cannot speak in its favour; for, honestly, it is but one more instance of a rehash of what has been written before in a slightly different form and style. As long, however, as publishers can be found to bring out works of the kind, either at their own or the author's risk, we suppose the same kind of operation will be repeated *ad nauseum.*

Medical Electricity and Massage. By H. NEWMAN LAWRENCE. London: Geo. Gill and Sons, Warwick Lane.

This handbook, by the Managing Director of the Institute of Medical Electricity, contains diagrams of the chief motor points and concise tables, showing the action of the muscles and nerves involved. It successfully aims at supplying useful data and hints for nurses and others who are being trained as operators in medical electricity and massage.

The Journal of the British Society of Mining Students, No. 3, Vol. XII.

This number contains an interesting account of the effect of a thunderstorm upon an underground endless rope at Kibblesworth colliery. The rope in question is one which works at some distance both from the shaft and surface and is not connected with any other rope. During the thunderstorm the men and boys handling the rope and its attachments received several electric shocks. Why these phenomena took place a perusal of the article in question does not afford much food for conjecture; in the absence of further evidence the reason seems likely to remain a mystery.

Journal of the Institution of Electrical Engineers, No. 83. London: E. & F. N. Spon, 125 Strand.

The general contents of this number are as follows:—"Report of the Council for the year 1889," continuation of discussion on Mr. Addenbrooke's paper on "Electrical Engineering in America," "List of articles relating to electricity and magnetism appearing in the principal technical journals during November and December, 1889."

NOTES.

Country House Electric Lighting.—Binfield Park, Bracknell, the seat of W. R. Cookson, Esq., is to be fitted with the electric light. There will in all be about 220 lamps distributed throughout the mansion and stables, and the generating plant will consist of a steam engine driving a Parsons dynamo in conjunction with a set of accumulators. The whole installation is being carried out by Mr. A. A. Campbell Swinton.

Taunton Lighting.—The town electric lamps were lighted from the new depôt for the first time last week. It is expected that the company will shortly be able to undertake domestic lighting on the incandescent principle.

Fighting Along the Line.—The carrying out of an order of the Board of Public Affairs permitting the Cincinnatti Electric Light Company to string wires on the poles of the Brush Company, gave rise to a riot on a small scale. When the police arrived on the spot, they found the poles manned by Brush men, armed with hatchets, who retreated upward. The police then arrested several of the Cincinnatti Company's men, the Brush men calmly surveying the battle from comfortable positions on the cross arms. The Cincinnatti men being routed and the Brush faction refusing to descend, the police officers started up the poles, when the Brush men, like the Colonel's coón, decided to climb down.

Experiments with the Leclanché Element.—M. Müller, telegraph engineer, has made some experiments as to the most advantageous construction and maintenance of the Leclanché element. The following is a summary of the results obtained by him:—1. The zinc must have a very reduced surface; this condition is best fulfilled by the cylindrical section. 2. The zinc is particularly attacked, and must, consequently, be protected at the level of the liquid—that is, where it is exposed to the simultaneous action of the air and the liquid. The best means of protection consists in covering the end of the zinc with a small India-rubber tube, which descends one or two centimetres below the level of the liquid. 3. The amalgamation of the zinc does not diminish its wear, but prevents, in a great measure, the adherence of crystallised deposits. 4. The formation of these deposits is very intense with solutions of 1 in 10 or of 1 in 15, while concentrated solutions and very aqueous solutions only give rise to an unimportant formation; a solution of 2 to 3 per cent. is most suitable. 5. It is advisable to furnish the element with a cover which hinders the evaporation of the water. 6. Contrary to what was generally thought, the zinc undergoes certain wear, even when the apparatus is at rest; the wear in itself is unimportant, but the chemical action which produces it is the principal cause of the crystalline deposits.

Parker's Electric Wire Corporation, Limited.—At an extraordinary general meeting of the members of this company, held on the 15th day of January last, it was resolved, in confirmation of a resolution made at a previous meeting, held December 30th, that the company be wound up voluntarily, under the provisions of the Companies' Acts, and that Mr. Arthur MacKenzie, of Temple Chambers, Temple Avenue, London, E.C., be appointed liquidator for the purpose of such winding up, at a remuneration to be thereafter fixed by the directors.

An Ingenious Device to Prevent Accidents from Live Wires.—*Modern Light and Heat* says: A number of electricians and others interested in electrical affairs met in the laboratory of Ernest P. Clark, on Pearl Street, New York City, a few days ago, to witness the workings of a new electrical device. It is an invention which, when applied to a high tension current wire, it is claimed, practically renders impossible accidents from live electric wires. Mr. Clark practically demonstrated the workings of his new device. It is a small contrivance and resembles an ordinary telegraph instrument. It consists of a coil of wire, through which is run a metal rod, on the upper end of which is a rubber button. The lower end of the rod comes in contact with the brass bar swinging in the centre like a see-saw. At the opposite end of the little bar is a lever like a switch, which connects with the dynamo and cuts off and turns on the current. The little swinging bar rests with a catch on top of this lever. The instant the charged wire is severed at any point along the circuit, the safety device is so constructed that the swinging bar drops from the metal rod in the coil, thus releasing the switch lever at its other extremity, and the lever thus released automatically cuts off the current from the dynamo. Mr. Clark cut a wire running overhead, which supplied a circuit of thirty lights in his laboratory. The little automatic safety device clicked, the lights were immediately extinguished, and the electrician picked up the severed ends of the wire and handled them with impunity. The inventor will shortly give public exhibitions of the workings of this device.

The Telegraph in China.—The convention relative to the transmission of telegraphic despatches, which was signed two years ago at Chefoo between the representatives of the Chinese Telegraphic Administration, the Eastern Extension, and the Great Northern Telegraph Companies, has only just been ratified by the Tsung-li-Yamen. The complete text of the convention has not yet been published, but it is already known that in the future the price of telegrams from all parts of China for Europe will be two taels per word (a tael is, roughly, about 4s. 6d.), which is the present price of telegrams from Hong Kong, Amoy, Foochow, and Shanghai, while telegrams from towns in the interior, such as Hankow and Pekin, pay 2½d. to 5d. per word more. It is thought, however, that in time this will be largely reduced. It is stated that the opposition at Pekin to the ratification of the convention came principally from the Marquis Tseng.

The Franco-Danish Cable. — The Franco-Danish cable, which was broken in three different places, has now been repaired after great difficulties had been overcome.

New Cable for New Zealand.—The telegraph ship *Scotia* was to have left the Thames on the 20th inst. with 1,300 miles of cable for the duplication of the present line between Australia and New Zealand. We understand that it is also proposed during the present year to lay another cable between Madras and Penang.

A Pretty Tale—for the Marines.—On the occasion of Prince Albert Victor visiting Calcutta, the lofty column dedicated to the memory of Sir David Ochterlony was lighted by electricity. According to the *Daily Graphic* correspondent, the effect was startling for the hundreds of natives from the country districts who had crowded in the capital of British India. "Some of them salaamed profoundly in honour of the wonderful vision, while others, taking to their heels, fairly bolted." As a matter of fact, the employment of electric lighting on public festive occasions is not by any means new in India.

Test of an Otto Gas Engine.—The *Journal of the Franklin Institute* contains an interesting account, with results, of an experiment made with a 7 H.P. Otto gas engine on January 19th, 1889.

Improved Dynamo.—Messrs. Parsons & Co., of Newcastle-upon-Tyne, inform us that they are now manufacturing dynamos of improved design. They are fitted with special balance weight brush holders, which always ensure exactly the proper amount of pressure being applied and preclude the possibility of the attendant causing undue wearing of brushes and commutator by improper adjustment of the pressure between them. The commutators are insulated with mica and are mounted on an independent steel brush. The machines are very strongly constructed in every particular, so as to stand rough usage and considerable wear and tear without injury; they also work excellently as motors. Messrs. Parsons and Co. are also manufacturing special slow speed dynamos of the inverted single horse-shoe type.

Telegraph Clerks.—In the House of Commons on Monday, Mr. Raikes informed Mr. Pritchard Morgan that he had a scheme under consideration which he thought would go a good way towards the abolition of deductions from the pay of telegraph clerks during absence from duty caused by sickness.

New Cable to Canada.—A petition has been presented to the Canadian House of Commons for the incorporation of a company for laying a cable to Canada. The cable will be run from Ireland through the straits of Belle Isle to Quebec.

An Electric Map of London.—We have received a copy of Mr. Stanford's map of London clearly defining the districts in which the various companies have powers of lighting. There can be little doubt as to its utility, and in our opinion it is the best map published in connection with the electric lighting of London.

Electricity and Wine.—A number of experiments made in Italy have proved that an agreeable "bouquet" may be imparted to wine by subjecting it for a certain time to the passage of an electrical current; and that wines which are not usually transportable may by this process be rendered capable, without detrimental consequences, of undergoing long land and sea journeys.

A Reminder.—Sir William Thomson has said, we believe, that a wire conveying 10,000 volts is not more dangerous in a laboratory than a circular saw. The dictum, says the *British Mail* in warning its readers against the dangers of high tension, only shows that professional men are sometimes enthusiasts. A circular saw can be seen and heard, whereas an electric current is silent; and even Sir William himself, though he would in general be well aware of his 10,000 volt wire, might some time forget the fact, and be fatally reminded of his inadvertence.

Electrical Trades Directory.—The new edition of the Electrical Trades Directory and Handbook for 1890 has just been issued by the Electrician Printing and Publishing Company. Its dimensions are considerably enlarged, necessitated by a considerable addition of original matter and tables, including valuable information relating to patents, the law of electric lighting and other matters. The portrait gallery is also increased, a good steel engraving of Dr. Hopkinson forming a frontispiece to that section. The alphabetical lists are much more accurate than they were in former years, and well represent the importance and extent of this section of the trading community.

Punishing the Turning Worm.—It seems that the Paris telephone authorities have to protect their *telephonistes* from the "impatience and anger" of subscribers. The penalty for this offence is the cancelling of the offender's subscription and repayment of the money. For the polite nation, *par excellence*, this is very discreditable, and assuming human nature to be very much the same on both sides of the Channel, the only inference to be drawn is that the ladies in State employment over there are excessively exasperating.

Electricity and Gas in America.—Notwithstanding the thousands of dollars that are now spent in all the large cities on electric lighting, the consumption of gas has, says the *Electrical Review* (New York) increased *per capita*. This is especially the case in Boston.

Berly's Electrical Directory.—Messrs. W. Dawson and Sons have just published the ninth annual edition of Berly's Universal Electrical Directory, which, they remind us, is the oldest publication of the kind in the world. Each year it not only grows in bulk, but becomes more and more complete, accurate and useful. By confining its contents to such information and classification as are associated with the idea and purpose of a directory, the publishers keep the size of the book within reasonable limits, and include nothing but what is of constant value for reference.

Lamp Hours.—Sir David Salomons has kindly forwarded to us the following extract, which will form part of a new edition of his work on accumulators :—

In the Future.—Prof. R. H. Thurston foretells that electricity will, by breaking up the factory system, "enable the home-worker once more to compete on living terms with great aggregations of capital in unscrupulous hands." This will be done in large cities by means of great steam engines sending the electric current into every corner of the town.

Further Details Necessary.—The Boston correspondent of the *Globe*, telegraphing on Tuesday, says : "A fatal accident occurred yesterday on the electric tramway here. Mr. George Bradford, a prominent merchant of this city, was riding in a street along which the tramway runs, when his horse became frightened at the approach of a car, and planted itself on the track. The car coming up at the same moment both horse and rider were knocked down and killed." Naturally such an occurrence might have happened had an ordinary car been on the line, but it looks as if the brake power was defective, or that the conductor's attention had been diverted in another direction.

Table showing till what hour in the morning Lamps are required for each month of the year.

	January.	February.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.
Beginning of month	8	7.30	6.30							6.10	7	7.45
Middle „ „		7.20								6.30	7.20	8
End „ „		7								7	7.45	8.10

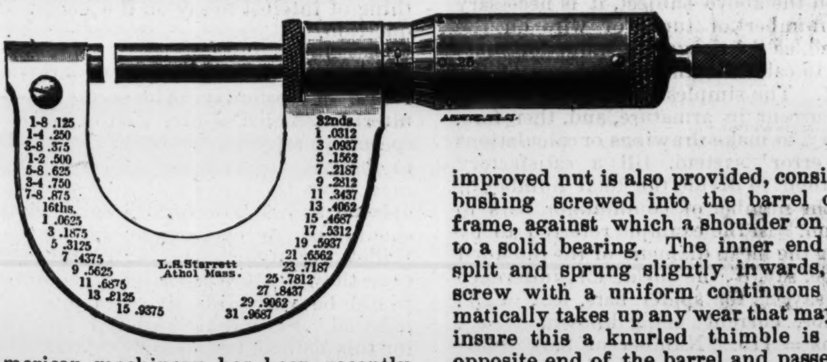
Table showing the time when Lamps are required in the afternoon for each month of the year.

	January.	February.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.
Beginning of month	4	5	6	6.30	7.30	8	8.15	7.45	6.45	5.30	4.20	4
End „ „	4.30	5.30	6.30	7.15	8	8.20	8	7	5.45	4.30	4	

The hours given in these tables are only approximate, being averaged over the portion of the month to which they refer.

Aluminium for Industrial Purposes.—According to the *Journal des Mines*, there is considerable talk in commercial circles of a new process which is to revolutionise certain industries, by making possible the production of aluminium at a price which will enable it to compete with iron and copper. A syndicate has been formed with the object of giving it an extended trial, and a factory, in the neighbourhood of Paris, has been selected for this purpose. It is said that a well-known banking house has taken the matter up.

Messrs. Charles Churchill and Company, Limited.—The firm of C. Churchill & Co., which has been established 25 years, and occupies a front place among importers of American machinery, has been recently formed into a limited company, which aims at increasing the scope of the business, especially as regards the heavier descriptions of machinery, and such as are specially suitable for electrical engineers and those engaged in the manufacture of small arms. A new catalogue has just been compiled, and owing to its large bulk, has been divided into two sections, namely, the engineering and the wood working and sundries. The engineering list consists of 178 pages, excellently printed by Goldie of Glasgow, and is interesting to every user of machinery and tools. We understand that many of the machine tools here illustrated have been supplied to electric light engineers in this country, and that the demand for high-class American machinery is steadily increasing. We notice amongst the smaller items in the catalogue, an improved form of the screw micrometer now so much used. It is called Starrett's speeded screw micrometer, the novel feature being a small knurled thumb-piece on the operating end of the spindle, as will be seen in the illustration, which shows the full size. By rotating this with the thumb and finger the screw is operated with thrice the speed attainable with the ordinary instrument, thereby saving trouble and time. An improved nut is also provided, consisting of a threaded bushing screwed into the barrel of the micrometer frame, against which a shoulder on the bushing comes to a solid bearing. The inner end of the bushing is split and sprung slightly inwards, so that it grips the screw with a uniform continuous friction, and automatically takes up any wear that may arise. To further insure this a knurled thimble is screwed into the opposite end of the barrel and passes over the tapering end of a split bushing inside. A slight turn of the nut contracts the bushing around the spindle to a close fit, or to lock firmly, thus making a solid gauge when desired.



Executions by Electricity.—Why not try one of the Brockie-Pell choking coils? (Found written on a blotting pad in the office of a well-known firm of electrical engineers, whose humane feelings do them credit.)

New York Subways.—Forty-three miles of new subways for the city of New York have been planned for this year. The streets of the city will, says a New York contemporary, present an animated condition.

Glass Conduits.—At Penderton, Indiana, a company has been organised with a capital of 500,000 dollars, with a view to constructing tiles and tubes of glass for underground wire work.

Ship Signals.—The Morse code of signals has been adopted by the U.S. Navy for signalling purposes, in place of the present cumbersome methods.

Electricity on the Alps.—The proposed railway up the Jungfrau, which is to be almost entirely underground, will, when completed, be lighted by electricity.

Liverpool Docks (Overhead) Railway.—It is expected that the Liverpool Docks (Overhead) Railway will be entirely completed by July, 1891. Electricity will be the motive power; but no definite system is to be adopted until the last possible moment, in order that the best may be obtained.

Electric Light on the Stage.—The supply of fairy lights for use in pantomime and ballet has come to be, during the past few years, a business of growing importance, the present pantomime at Drury Lane affording an evidence of the brilliant effect produced by a liberal use of them. Mr. Richard Allbright, who supplies these lights, has made this branch his speciality, and not only at Drury Lane but also at the Empire, the Crystal Palace and other places of amusement has carried out this kind of decorative lighting with perfect success.

The Electro-Harmonic Society.—Next Friday brings with it the Amateur (Ladies' Night) Concert of this society. The programme will be carried out entirely by members and their friends, and doubtless a very pleasant evening will be spent. We may take the present opportunity of notifying to the supporters of the society that Dr. John Hopkinson, F.R.S., President of the Institution of Electrical Engineers, has kindly consented to preside on the evening of March 28th, if nothing unusual happens to call him away, when a smoking concert will conclude the series for this season.

Designing of Dynamos.—The following came too late for insertion in our Correspondence columns:—"In the application of the formulæ, given in Prof. Jamieson's article on the above subject, it is necessary to determine the number of turns of wire on the armature beforehand, as the magnetic induction must be known in order to calculate the dimensions of the armature core itself. The simplest method is, having given strength of current in armature, and, therefore, size of wire necessary, to make drawings or calculations on the 'trial and error' system, till a satisfactory design is obtained, then to divide the total number of turns so found by the number of commutator bars to give turns per section. In the example referred to by Mr. Conry, assuming the mean diameter of the intended armature core to be, say, 8″, the mean circumference = about 25″; less, say, 2″ for spider bars, &c., = 23″. Width of conductor, current being known, = ·2″; ∴ number of turns = 115. Number of bars = 36; ∴ turns per section in one layer = 115/36 = (nearest) 3. There being two layers, number of turns = 3 × 2 = 6 per section."—A. H. A.

An Electrician as Landlord.—A case is being tried in the French courts in which the landlord seeks to restrain the use of the electric light by his tenant in the shop leased by the latter. The curious part of the case is that the landlord is a well known electrician and the author of several noteworthy works on electricity.

A New Primary Battery.—This battery, the invention of M. Baron, has for its elements—oxides of lead, carbon and zinc, in solution, and, in certain cases, ammoniacal alum and tartaric acid. In these batteries the carbon is consumed and does not only act as a conductor. The exciting liquid is said to be made of 20 kilogrammes of retort or wood carbon, 100 litres of water, 20 litres of sulphuric acid, and 10 kilogrammes of zinc; the liquid so formed immediately boils up, when 5 kilogrammes of minium or of litharge is added; when the ebullition ceases, 20 litres of nitric acid are added. The new battery is said to give wonderful results; 6 cells, each of 1½ litre capacity keeping *continually*, 12 times for 24 hours, an 8 volt lamp burning, with only the change of a salt and water solution in the porous cells of the battery. It is not at all evident what other electrode besides carbon is employed in the new combination, and, indeed, the whole matter has a suspicious look about it.

The Weymersch Battery.—In our issue of June 22nd, 1888, we published some tests of this excellent primary battery, and we are pleased to find that the inventor has since then been steadily improving its form for practical and domestic uses, and is now exhibiting it in operation for purposes of illumination to all who may be interested. The offices of the Weymersch Battery Syndicate are at No. 2, Victoria Mansions, S.W., and there may be seen the battery applied to lighting ceiling and wall lamps, and also to a variety of more or less portable lamps. Some large and important installations have already been entrusted to the Syndicate, but if it simply confines its attention to the supply of installations where a few lamps only are required, the scope for its operations is immense. One very successful application of the battery shown at the offices is that to the lighting of a "Planet" arc lamp, which burned with remarkable steadiness and gave an estimated light of 400 candle-power.

Bristol Lighting.—The specification which Mr. Preece was instructed to prepare, preliminary to inviting tenders for the lighting of an experimental area in the city, has been laid before the local electric light committee. As in the case of Bath, the wires are to be placed underground, and there will be no interference with the gas plant. The area to be lighted extends from the Drawbridge to Narrow Wine Street, and from Bristol Bridge to St. John's Church, Broad Street.

The Supply of Electricity.—To-night Mr. George Offor lectures at St. James's Hall, Piccadilly, on the supply of electricity (action of the local authorities and Board of Trade). Doubtless Mr. Offor will have something of interest to say on the commercial side of the question.

Brighton Electric Lighting.—In the Sussex *Daily News*, of yesterday, Alderman W. H. Hallett, J.P., utterly demolishes Mr. Killingworth Hedges, whose speech we reported last week. It is, indeed, remarkable to observe with what ease the vapourings of this gentleman have been met and disposed of, and this little episode shows how careful some electrical engineers should be in making public statements. As Mr. Hallett rightly observes—"To suit a momentary purpose they venture assertions, the integrity of which would be very difficult to maintain before a skilled tribunal. Several have lately been in Brighton adopting this method, but Mr. Killingworth Hedges is successful as yet in being the most notorious."

Rashleigh, Phipps and Dawson.—If the contracts which this young firm has already completed, and those now in hand, give any indication of what is going on generally in the electric lighting world, there must be a vast amount of good solid business stirring. A letter, which Mr. John Hare, of the Garrick Theatre, has sent to Messrs. Phipps and Dawson, bears eloquent testimony to the careful manner in which they carry out their work.

The Gas Light and Coke Company.—Nothing has occurred since the issue of the last report to alter the opinion of the directors that the progress of electric lighting will not produce any injurious effect upon the business of the company.

NEW COMPANIES REGISTERED.

Archer Pipe Company, Limited.—Capital, £10,000 in £1 shares. Objects: To construct and lay down pipes, culverts and appliances for carrying or containing water, gas, electric light, telephone, telegraph and other wires, cables and lines, and to acquire two letters patent granted in 1886 and 1889 respectively, for improvements in pipe joints, and for improvements in method of and machinery for making earthenware pipes. Signatories (with 1 share each): Colonel A. Hamilton, 41, Lennox Gardens; Isaac Williams, 5, Marlbro' Road, Chiswick; H. A. Hart, 12, Ascburch Grove, Shepherd's Bush; H. Smith, The Bourne, Chiswick; Henry Bird, 11, Queen Victoria Street; E. H. Bayley, 142, Newington Causeway; R. Ewing, 51, Gracechurch Street. Registered 13th inst., by Ashurst, Morris, Crisp & Co., 6, Old Jewry.

Poole and White, Limited.—Capital £20,000 in £5 shares. Objects: To take over the business of Poole and White, and to carry on electric lighting business in all branches. Signatories: *T. G. Poole, 58, Bread Street, 10 shares; W. White, 58, Bread Street, 10 shares; Fisher Smith, J.P., 34, Avenue Road, N.W., 50 shares; *J. Tryon, 1, Stone Buildings, Lincoln's Inn, 40 shares; Arthur Moss, 28, Lincoln's Inn Fields, 40 shares; N. Heaver, 8, St. James's Square, Notting Hill, 1 share; F. H. Snow, 31, Oatshell Road, Putney, 1 share. The signatories denoted by an asterisk are the first directors; qualification for directors, other than T. G. Poole and Wm. White, 50 shares; the company in general meeting will determine remuneration. Each managing director will be entited to £250 per annum, in addition to the ordinary remuneration of directors. Messrs. T. G. Poole and Wm. White are the first managing directors. Registered 18th inst., by Saltwell and Tryon, Lincoln's Inn. Registered office, 58 and 59, Bread Street, Cheapside.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Dalziel's Cable News Agency, Limited.—The statutory return of this company, made up to the 3rd inst., was filed on the 4th inst. The nominal capital is £1,000 in £5 shares, the whole of which are taken up and the full amount has been called thereon. The calls paid amount to £995 and unpaid to £5. Registered office, 263, Strand.

Foreign and Colonial Electrical Power Storage Company, Limited.—The statutory return of this company, made up to the 10th inst., was filed on the 14th inst. The nominal capital is £100,500 divided into 200,000 ordinary and 100 founders' shares of £5 each. The shares taken up are 502 ordinary and five founders', but no call has yet been made upon any of the shares. Registered office, 4, Great Winchester Street.

Fowler, Lancaster and Company, Limited (Electricians).—The registered office of this company is situate at the Albert Works, Graham Street, Birmingham.

Fareham Electric Light Company, Limited.—The registered office of this company is situate at Westbury Lodge, West Street, Fareham, Hants.

Wrexham and District Electric Supply Company, Limited.—The registered office of this company is situate at "Yspytty," No. 12, Queen Street, Wrexham.

Purnell High-Speed Gas Engine Company, Limited (Gas and electrical engineers).—The registered office of this company is situated at 153, Fenchurch Street, E.C

CITY NOTES, REPORTS, MEETINGS, &c.

Chelsea Electricity Supply Company.

THE ordinary general meeting was held on Wednesday last at the company's central station.

Mr. John Irving Courtenay, Deputy-Chairman, said: It is my duty, in the absence of Lord Thurlow, to address some observations to you before I move the adoption of the directors' report and balance sheet. You are aware that though the company was registered some time ago the present board of directors was not constituted, nor was the capital obtained for the construction of the works until after the passing of the Electric Lighting Act of 1888; but it was necessary to include in the balance sheet such small outlays as were made by our predecessors in office. The Board of Trade inquiry necessitated a heavy expenditure, which was absolutely necessary to incur to defend our position, and again we had to take part in the proceedings before the Committees of the two Houses. The figures are fully given, not only in respect of these matters, but of every detail connected with the capital and working account in our balance sheet and profit and loss account, and I do not purpose to detain you by a recapitulation of them, but I am prepared to answer any questions upon them, and to give any shareholder such further information as he may require. The whole of the work has been carried out by the Brush Electrical Engineering Company, the Callender Company, the E.P.S. Company and the Electric Construction Corporation. Our central station has been open for the supply of electricity since the second week in April last year, when current was first turned on from the 2,000 light storage battery sub-station at Clabon Mews. Since then the increasing demand for electric light has induced the directors to open two other similar battery sub-stations in different districts, and the plant for a fourth is in course of erection. We began with eight houses in April. During the summer, as a matter of course, the increase was slow. By the end of September we were supplying 41 houses, or 2,990 lights. By 31st December the number had increased to 93 houses, or 8,730 lights, and we now have on our books 134 houses, or over 10,000 lights. I would point out that one of the advantages of the system adopted at Chelsea is, that it lends itself readily to gradual increase of plant, according to the necessarily gradual increase in the demand, and does not necessitate at starting the large expenditure of capital on buildings and heavy machinery, as with direct running systems, in which a long time may elapse before sufficient work can be found to fully employ the plant. All the electricity which has been produced has been supplied to the consumer direct from the E.P.S. storage batteries. The consumer is never, under any circumstances, in connection with the charging current, and therefore he is not subject to the disagreeable pulsation and inequality in the light often noticeable when it is produced direct from running machinery. Nor is he in any way liable to the inconvenience of sudden total extinction of his light from difficulties or mishaps with boilers, engines, or dynamos. It is an interesting fact that upon the E.P.S. system, when the batteries are being charged, the engines and dynamo electric machinery are always operating under the conditions of highest efficiency and maximum output. This is proved in practice by the small consumption of coal, which, for every Board of Trade unit actually supplied to the consumer's lamps, has an average of about 11 lbs. You will be gratified to learn that little or no symptoms of wear are discoverable even on those E.P.S. batteries that have been longest in use, and in no case has a single plate had to be renewed. I wish to call particular attention to this question of depreciation of accumulators, because it is one of the main points urged against their adoption. I have always contended that in practice it would be found that when storage batteries were installed in central stations (where one man can look after several hundred cells with as much ease as he can look after a few in a private installation) that better results would be obtained than had almost ever been got before, and experience is now showing this to be a fact. When by the automatic arrangements of Mr. F. King's system the batteries have their proper charge regularly, and are not permitted to be unduly discharged —that is, discharged beyond their capacity, in other words, when the batteries receive ordinary intelligent treatment—their life will be considerably prolonged. The batteries in this station are all in glass cells, and you can therefore judge for yourselves what excellent condition they are all in; but a still stronger answer is found in the fact that the manufacturers are prepared to supply all the necessary material for the renewal of any plates or portion of the battery that require renewing, at the annual rate of 12 per cent.; but here at Chelsea, where we have engineers who are well acquainted with E.P.S. storage batteries, we have declined this offer of the manufacturers, because we prefer to be our own insurers, as we know it will cost us less than that. You will observe the remarkable comparative statement in the report for the first complete quarter ending the 31st December, from which it will be seen that in the month of October, for coal, water, wages, &c., the expenditure was £82 0s. 10d., while the "current" invoiced to customers amounted to £146 1s. 6d.; for November the cost for the same items was £114 14s., and the amount invoiced £262 8s. 2d.; for December the cost was £141 9s. 6d., and the amount invoiced £405 12s.; that is, in November for an expenditure of 39 per cent. greater than that in October, the increase in revenue is 79½ per cent. more than in October, or double the increase in expenditure; and in December, for an expenditure of 23⅗ per cent. more than in November, the increase in revenue is 54⅜ per cent. greater than in November, or considerably more than double the increase in expenditure. The cost of producing a Board of Trade unit of electricity was, in October, 4¼d.; in November, 3⅜d.; in December, 2⅔d.; and this should be further improved when our system of underground conductors is quite complete. I venture to say that no other company nor any other system now being operated in this country could show similar results, and if there is any such, at any rate, I am not aware of it; and I shall wait with interest to learn whether any similar equally satisfactory results have been produced elsewhere. The success which has attended the working of the E.P.S. system at Chelsea is making the advocates of other systems, notably, the high tension alternating current system, very unhappy, they are greatly exercised in their minds, and have rushed into public meetings and print, and if the statements attributed to them in the Press are a correct version of what they are saying, they certainly show an amazing hardihood of statement in connection with storage batteries. Storage batteries, now, can be relied on, and can be guaranteed to give 70 per cent. on an average, in practical working on a commercial scale, of the amount of electricity put into the battery, and they ordinarily give more; and I am informed, by those who have made a close study of the subject, that the alternating current system, with transformers working over the whole 24 hours, will have an average efficiency of not more than half the average efficiency of the storage battery system. I am, of course, fully aware that those who are interested in rival systems argue that the great drawback to the storage system is the initial cost. But I maintain the difference in favour of other systems (if any) will disappear if an adequate duplication of apparatus, plant, and buildings is provided. Should even the original cost of the plant for the storage system be a little greater, surely it is better, in the first onset, to put down apparatus that will give the highly efficient results that I have shown, than to adopt other systems that are less reliable and have higher working expenses, such as is necessitated by the absence in those systems of a storage reserve, and when they have got this reserve plant they are still liable to breakdowns of moving machinery. In other words, I say that the customers of the Chelsea Company are supplied with a better article than can be given by any other system, and at the same price, and there can be no question that the public are beginning to appreciate this. I have felt bound to make these observations in consequence of the public attacks that have been made upon our storage battery system. You will be gratified to learn that though the vestry of the important Parish of St. George, Hanover Square, refused to consent to our application for a provisional order in 1888-9, they have now, on our being able to show such good work in Chelsea and Kensington, unanimously consented to allow our application to the Board of Trade for a large portion of their parish, in spite of the fact that two other companies have already been granted powers in the same district. We are vigorously pushing our business in Chelsea and Kensington. What we have to do now is to add on houses, and so increase our customers as rapidly as we possibly can, and, I think, you will agree that in view of the good progress we have lately made in this respect, there is every reason to expect a large increase during this year. I am assured by those who are acquainted with our central station, sub-stations and plant, the solid manner in which they have been constructed and laid down, and the efficient way in which they have been working, that we shall have no difficulty in obtaining, at a moderate rate, the debentures necessary to successfully carry on the prosecution of our extensions; and the increasing ratio of income over expenditure, as already shown, is sufficient evidence that the issue of debentures, by enabling us to extend our mains and use our central station to its full capacity, will prove eventually a great benefit to our shareholders. I beg to move the adoption of the directors' report and statement of accounts.

Mr. Daniells seconded.

Professor Ayrton said the cost of producing the Board of Trade unit in October being 4¼d., in November, 3⅜d., and December 2⅔d., he wanted to know whether the last included coal only.

The Chairman said the charges were precisely similar. He had them worked out by the staff, and complete reliance could be placed on their engineers, who worked out the figures. He was assured by the staff that they were perfectly correct, and although feeling a little hesitation at first, he came to the conclusion that he was justified in publishing them. He had little doubt that the statement would be the subject of much controversy.

The motion was then put to the meeting and carried unanimously. The retiring directors, Major-General Webber and Mr. Daniell were re-elected, as also were the auditors.

The following resolution was then put to the meeting and adopted: "That the directors be, and they are hereby authorised to borrow a sum not exceeding £50,000, and to secure the same by the issue of debentures in such form, secured in such manner, and issued to such persons on such terms and at such times as the directors may deem expedient."

A vote of thanks to the chairman brought the meeting to a close.

City of London and Southwark Subway Company.

THE eleventh half-yearly ordinary meeting of this company was held at Winchester House, Old Broad Street, on Tuesday last, to receive the report of the directors and statement of accounts, &c. Mr. C. G. Mott in the chair.

The Secretary having read the notice convening the meeting, and the report having been taken as read,

The Chairman said that it was with a mingled feeling of regret and satisfaction that he rose to move the adoption of the report and accounts—a feeling of regret because they again met with an unopened line, and a feeling of satisfaction because during the past half-year most excellent progress had been made with the work of the line. They would learn from the report a good deal about the work actually carried out, but he might specially call their attention to the very important work of driving the tunnels through the wet gravel, which had been going on uninterruptedly during the whole of the past half-year, with the result that one of the tunnels had been completed, and that the other had only about four or five weeks before it would touch the clay on the other side. Anyone who knew what the difficulty of the work had been—how, as a class of work, it had been almost unexampled in the annals of engineering—would appreciate the importance of the tunnel having been driven so steadily and safely as it had been through most difficult strata, so that the two ends, where they joined, met almost exactly. That was exceedingly creditable to the contractors, to the engineers, and to the engineers' staff. The other tunnel, also, had progressed perfectly safely so far. They had also, during the past half-year, completed the boiler house; great care had been bestowed upon the erection of the boilers—the principle adopted was an extremely economical one, and free from annoyance to the surrounding neighbourhood. Six boilers were being used without, practically, any smoke arising from them. As the boilers were situated in the midst of a residential neighbourhood he thought this a proper subject for congratulation. The engine house, in the same depôt, was also rapidly approaching completion, and preparations were being made for fixing the engines and dynamos. They had now to arrange for the necessary engines, &c., for working the hydraulic machinery, which was a very expensive item, seeing that there were to be two large and important lifts at every station—that was to say, twelve lifts in all; and arrangements had also to be made for the electrical lighting of the stations and carriages. Another piece of tunnelling, which had been a somewhat difficult work, as part of it had been through wet gravel, was, he was happy to say, now almost finished, and a few days would see a rope through it. He referred to the incline, from the Stockwell depôt into the tunnels, by which the whole of the plant and working stock of the railway would be conveyed up and down. The fixing of the lifts had been fairly commenced; of course, a great deal of that work consisted in the preparing of shafts, several of which were now completely finished. There was still the very important question of the electrical power to be used in working the line. In all these matters the directors had necessarily to feel their way to some extent. They had been working an experimental locomotive and carriages in the tunnel between King William Street and Dover Street; that being, in fact, the most difficult part of the line to work, because it went under the river, it was thought desirable to make the experiments there. They had now been carried on for nearly six months, with the result that great improvements had been made in the locomotive employed. Trials with a second locomotive had been commenced only yesterday, and he could say, speaking from his experience in the trade, that it worked most admirably. As the result of these experiments, a locomotive would be constructed which would be fitted in every way to do the work thoroughly and efficiently. The locomotives that were now building would, he believed, be completed in perfect time for the opening of the line. They would have noticed that the result of the near completion of their line had been to satisfy many engineers and others of the value of the system adopted in this case, evidenced by the fact that some five new companies had given notice to obtain Parliamentary sanction in the present session for the construction of similar lines in different parts of the metropolis. Of these schemes, however, for financial reasons, he believed, there was only one left; but possibly there might be two The one he referred to was a very important one; it proposed to run from Queen's Road, Bayswater, down Oxford Street, Holborn, Newgate Street, and Cheapside to the Bank, where it was to have a great central station, from which it would run until it formed a junction with their own line just where it left King William Street station. If that scheme should receive Parliamentary sanction, and there seemed to be very good reason for supposing that it would, since there appeared to be no practical objection to it, it would, of course, be a great feeder to the company's line. The only difficulty that the company had experienced with it was that it was not proposed to make the junction at a station, but in another and less satisfactory way; the directors, however, hoped that by means of negotiations a satisfactory arrangement of the difficulty would be arrived at. He only mentioned it to show how completely those who were watching the progress of the undertaking were satisfied of its being the kind of thing that was wanted for the metropolis. The proposed junction with the Oxford Street line might render it necessary to construct a station close to the terminus of the Brighton and South-Eastern Railway, and they had therefore included in their proposed bill power to make a line to that station, should it be necessary, but they did not intend to carry it out unless the necessity arose, and the shareholders would hear further of that matter. Another point he might mention: they knew that the company had a name which did not at all express the scope of its undertaking. They were called a "Subway" Company. The original idea was that it would be a subway for pedestrians. The next idea was that it would evade the required regulations as regards railways. Neither anticipation had been accomplished. The idea of walking through the subway was long since abandoned, and in the next place Parliament, the Board of Trade, the Stock Exchange, &c., had ranked them as a railway; consequently they thought it better at once to assume the name of railway and drop that of subway. They therefore proposed to obtain Parliamentary sanction for changing the company's name from the City of London and Southwark Subway Company to that of the Cities and South London Railway. Regarding the accounts, they indicated pretty clearly what had been done in the way of expenditure. The directors had power to issue a further £50,000 debentures, making £150,000 in all. Of these there were some £30,000 not yet taken up. They had, as the shareholders were aware, been issued—he thought very wisely—as terminable debentures for five years; and they had therefore to pay a higher rate of interest for them. The directors thought that a very much better arrangement than issuing them as debenture stock as a permanent charge at a higher rate. When they fell in the directors hoped to issue them as permanent debentures at a lower rate. The arrangement had been successful, most of the debentures had been taken up, and the directors would be very glad if any shareholders would avail themselves of the higher rate of interest for the next five years by taking up the remainder. They might desire some information as to when they might hope to have the line completed and open. He had carefully avoided fixing this beforehand, because of the newness of everything they had had to do. Everything about the construction, the working, and the appliances connected with it had been new, and it was always difficult to foresee, with so many special contractors, as to the time when their work would be completed. But he hoped that some time before they met again, in July or August, their railway would be open for traffic. (Laughter.) He then moved the adoption of the report and accounts.

The motion was seconded by Mr. Robinson.

The Chairman, replying to a shareholder, said the latter might be perfectly easy in his mind with regard to the unfinished piece of tunnelling. It was strong, hard, sound gravel, although full of water. It was surrounded on the outside by a line of concrete, and anyone acquainted with the subject knew wet sand and gravel gave a perfectly even pressure all round, and afforded a solid and good foundation. He did not apprehend the slightest risk; the completion of the tunnel was merely a question of time and of proper appliances, which they now had. As regards the other question asked touching the contractors' liability, it was the ordinary liability for maintenance, and continued, he believed, for twelve months after completion. As some of his friends in front seemed to think his statement about the date of opening of the line perhaps a little vague, he might tell them that all the contractors were of opinion that it would be completed by the end of May, and hoped to have it opened by the end of June. Unfortunately in a case like this they had so many contractors, and it was difficult to answer for them all.

The report and accounts were then passed. Messrs. C. S. Grenfell and Alexander Hubbard were re-appointed directors, and Messrs. Turquand, Youngs and Company and George Kitson auditors of the company.

SPECIAL MEETING.

At the close of the ordinary general meeting as above a special general meeting was held, with Mr. Mott in the chair, for the purpose of considering and, if thought fit, approving a Bill proposed to be introduced into Parliament in the present session, entitled "A Bill to empower the City of London and Southwark Subway Company to extend their authorised subway to Clapham, to change the name of the company, and for other purposes."

The Chairman said he had purposely waited for the special meeting in order to explain the main feature of this Bill. The original conception of the line and the form in which the scheme was first presented to Parliament was, that it should run from the present station in King William Street to Clapham. That was subsequently altered, and it was thought better to present the scheme in sections. The first section, they were aware, extended to the Elephant and Castle. When that Bill was obtained they went for a further section, which was to carry the line to the Swan. It was thought better not to go further in order to avoid unnecessary opposition. They now proposed to go for the final section, which was something under a mile beyond the original terminus. There was no doubt that at that final terminus there was an aggregation and collection of traffic, which would be of great importance to the company. It was a very busy centre; and as the extension could be carried out at a cheaper rate per mile than the present line, it was desirable to extend the railway to that point. It would enable them to get a great deal more traffic per mile than they would otherwise have obtained. The shareholders were now asked to approve the action of the board in giving notice of the Bill; it had been done after very careful consideration.

The company's solicitor having read the Bill the chairman moved its adoption by the meeting. The motion was seconded by Mr. Robinson.

The Chairman, in reply to shareholders, explained that the assent of the meeting to the motion before them would in no way empower the directors to carry out the proposed extension, for which a special consent of the shareholders would have to be obtained at a subsequent meeting. The same motive power would work the whole line.

A Shareholder thought the line might be taken even further than had been proposed, Clapham Junction, he thought would make a better centre. It was enormously increasing in population, and there was no direct route to the City from it.

The Chairman said the directors preferred a medium course. However, they were on the road to Clapham Junction, and the question of further extensions would doubtless arise by-and-bye when they had seen the fate of the proposed Oxford Street railway.

The meeting then broke up with a vote of thanks to the chair.

India Rubber, Gutta Percha and Telegraph Works, Company, Limited.

THE 26th ordinary general meeting of this company was held last Friday, at the Cannon Street Hotel, Mr. S. W. Silver in the chair.

The Chairman, in taking the report as read (published in the REVIEW last week), said the directors had much pleasure in rendering an account to their shareholders of the operations of the past year. These showed a balance of £57,748 9s. 1½d. to net profit, bringing, together with the balance of last year, £2,036 6s. 8d., for disposal. Out of this the directors recommended 10s. per share, *i.e.*, 10 per cent. for the year, leaving £41,236 6s. 8d. to be carried forward. They had specially to report upon as regards the telegraph and electrical departments. As he had told them at the last meeting, the laying of the cables on the West Coast had been completed in the most satisfactory manner. Their steamers had also been partially employed. The purchase of the Liverpool premises had been made in consequence of the lease expiring; in the interests of the company the directors thought it better, as preventing any further interruption to business, to purchase the freehold of the adjoining premises; and the extension of the London warehouse spoke for itself. The company's general trade operations showed about the same amount as last year, notwithstanding the adverse circumstances it had had to contend with, with which the shareholders would be all more or less familiar, and which had almost prevented their participating in the general improvement in the trade operations of the country. Regarding the Silvertown strike, they need not go far to seek the cause of it. The dock movement had taken place in the vicinity of the company's works and a number of their labourers had allowed themselves to be influenced by a clique of professional agitators and by several irresponsible persons, who, he thought, would now admit that they had make a mistake. The demand made by the men for an increase of pay, notwithstanding that their wages were in excess of those paid in the locality, had been refused, and this led to attacks upon workmen, considerable numbers of whom were inclined to pursue their daily avocations, and had given rise to the unmanly system of picketing, and, in fact, a reign of terror had been established, which was traceable to the inaction of the police. He had no hesitation in saying so, as, at a later stage, when the police adopted more active measures, the entire movement had collapsed and the employés returned quietly to their work on the same terms as before. To the firmness and sound judgment of their absent friend, the managing director, must be attributed that happy conclusion. Mr. Gray had been ably supported, at considerable personal risk to themselves, by his sons, by the whole staff of electricians, by the clerks, the young men in the countinghouse, the foremen and a strong force of assistants, including several workmen and workwomen, so that the works had been kept going throughout. From the outset Mr. Gray had had the entire confidence and support of the whole Board; through his lengthy and active life it had been his one object and aim to see that his workpeople were justly and kindly treated. He had remonstrated with those workmen and had reminded them of the terrible consequences of their action, the whole of which had come to pass. His absence that day was to be regretted. It was the first time they had missed him. He was seeking rest, and, in his absence, his son, Mr. Robert Gray, would supply his place. He, the speaker, hoped and believed that the time was not far distant when the era of strikes might be chronicled; and he had little doubt but that which had taken place in Silvertown, within the past half year, would form an important chapter; and he also felt sure that great prominence would then be given to the part taken by their absent friend. He ought not to close his remarks without referring to the Persan-Beaumont works, which had done good work for the company. Without detaining them longer he would move the first resolution:—"That the report and accounts now presented be received and adopted, and a dividend of 5 per cent., or 10s. per share, free of income tax, payable after the 15th inst., be now declared."

The motion was seconded by Mr. Bannatyne.

Mr. Webber said he would like to propose an amendment to the effect that the directors declare an extra dividend of 5 per cent. He had bought his shares at a very heavy premium, and considering that the board were about to carry forward £41,000, he considered it very unfair to the shareholders.

Mr. Codner seconded the amendment.

The Solicitor to the company said it would not be in order with the 9th clause in the articles of association, which was to the effect that a motion with reference to dividend carried by the shareholders would not have effect unless sanctioned by the board; as Mr. Webber's motion was against the wish of the directors, it would fall to the ground.

The Chairman said the amendment preposed by Mr. Webber would be of no avail in any case. The reason for carrying forward such an amount was that they found it an advantage to be in the position of being able to buy the raw material judiciously in any quantity, and that during the past year it was one of the sources of profit. The competition in the manufacture of their goods was such that they had to be very careful in laying in their stock of raw material; he believed he had answered the only question.

The motion that the accounts be adopted was then put to the meeting and carried.

Mr. Bannatyne moved the re-election of Mr. Silver and Mr. Marsham as directors, which was agreed to.

Prof. Price then proposed the following resolution: "That this meeting declares and herewith places on record its sense of the great and valuable service rendered to the company during the recent strike at Silvertown, in the firm, prudent and just action of the managing director, and tenders to him its acknowledgment for these services; secondly, the meeting places on record its grateful appreciation of the services rendered to the company by the chief manager and the heads of the several departments in the works at Silvertown during the strike."

This was seconded by the Chairman and adopted.

A vote of thanks to the chairman for presiding, brought the meeting to a close.

The Société Générale des Téléphones.

In our last issue we gave some brief particulars of the meeting of the above company, and we now append some further details from the report as to the proceedings which the Council of Management has taken to protect the shareholders' interests. The first action taken was lodged at the Conseil of the Prefecture of the Seine on April 23rd, 1889, to claim the execution of the agreement entered into by the company with the Ministry of Posts and Telegraphs on July 22nd, 1886. This claimed the execution, pure and simple, of the said agreement. When the Chamber of Deputies had authorised the demand for purchase put forward by M. Coulon, late Director of Posts and Telegraphs, this action was transformed into a claim for 10,000,000 francs damages. The agreement of July, 1886, was for 35 years, an appeal was then made to the Council of State, objection being taken to the referee's ordinance of August 13th, 1889, which was lodged by the President of the Council of the Prefecture of the Seine, on the demand of M. Coulon and naming M. Jousselin sole expert in the litigation. This ordinance was taken by application of Article 24 of the Law of July 22nd, 1889, and M. Jousselin was instructed to make an estimate of the matériel, &c. Despite this protest, the ordinance was upheld because it was not susceptible of opposition. A second appeal was then lodged by the Société Générale des Téléphones against the order of August 30th, 1889, signed by the Minister of Commerce, enjoining the Administration of Posts and Telegraphs to put itself in possession of the offices of the company, if necessary with the aid of armed force in case of resistance. That constituted an abuse of power, for the company's offices served also as sale and show rooms for a private industry, that of telephone cables and India-rubber. Finally, in August last, a summons was addressed to the Direction of Posts and Telegraphs to pay a sum of 20,000,000 francs for the material value of the company's telephone lines, plus an indemnity to be fixed for deprivation of possession. This last was made specially to safeguard the interest which might be due. In regard to other matters, the report shows that during the last few years the commercial and industrial portion of the company's business has largely extended. The company has two works, the one in the Rue des Entrepreneurs at Paris, and the other at Bezons. The first is engaged in the construction of telephone matérial. The company holds several patents which always assure it plenty of work, the State itself being obliged to have recourse to it. Its business is increasing so greatly that it is about to make large additions. The other works, at Bezons, is engaged in the manufacture of India-rubber articles and cables for telephone lines. The company is about to open a new branch, that of submarine cables, which does not yet exist in France, and for which that country has to go abroad for its supply. This branch, for which the company is in agreement with the Société Française des Télégraphes Sousmarins, promises well for the future of the company.

The Direct Spanish Telegraph Company, Limited.—The board, subject to audit, decided on Tuesday to recommend the payment of a dividend at the rate of 10 per cent. on the preference shares and a dividend at the rate of 6 per cent. (free of income tax) upon the ordinary shares, making 5½ per cent. on the ordinary shares for 1889 against 4½ per cent. in 1888, and to carry forward £846.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending February 14th, 1890, amounted to £4,662.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 14th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,549.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 15th February are £3,581, as compared with £3,348 in the corresponding period of 1889.

THE TIMMIS SYSTEM OF ELECTRIC TRAIN LIGHTING.

On Tuesday last an inspection took place at the Lancaster Wagon Company's Works, at Lancaster, of a train for the Central Argentine Railway (Sir Douglas Fox), fitted with the electric lighting arrangement designed and patented by Mr. Illius A. Timmis, M.I.C.E., of Westminster. The electric lighting arrangements were shown in actual working order, and the trials and experiments were witnessed by representatives from many of our leading railway companies.

Mr. Timmis has already fitted up trains on his system for several foreign railways, and he is at the present time engaged in fitting up a number of trains in Russia, France, and South America, in addition to the two trains now on hand for the Central Argentine Railway.

In the system designed by Mr. Timmis, he has carried out the following essential conditions:—Every vehicle must carry its own lighting power, in the event of its being put into a siding, slipped, or break loose from a train. The guard must have the power to light, or put out, all the lamps in the train. If one or more vehicles are slipped, or break loose, the lamps in them, if lit, must remain lit, and if not, they must automatically light up. Intercommunication between passenger and guard.

Mr. Timmis carries out his plan of electric lighting under two systems:—The A system, with a dynamo driven from an axle; the B system, with a dynamo and engine on the locomotive or tender, and the latter was shown in operation at Lancaster. The train consisted of six long bogie cars and one van, with eleven double lamps in each car for main lighting, and six auxiliary lamps. These cars, we may here remark, are very spacious, elegantly built, and appear well suited and furnished for the climate in which they are to run.

The engine and dynamo, which are coupled direct, are very compact and light; protected from dust, they are on the same bed-plate, and are fixed on the side front foot-plate of the engine near the smoke box. The engine, of the Westinghouse type, built by Messrs. Alley and Maclellan, of Glasgow, is of 8 indicated H.P., and runs at 600 revolutions per minute, with 140 lbs. steam pressure, the steam being obtained from the locomotive boiler. The dynamo is a very neat and compact "Phœnix," by Messrs. Paterson and Cooper, with an output of 52 volts and 100 ampères. The running of this dynamo was very even, and the lamps were remarkable for their steadiness with direct coupling. The dynamo and engine, encased, occupied a space 5 feet in length by 20 inches in breadth and 3 feet high, the total weight being 35 cwt.

The double lamps are of 8 candle-power and 50 volts, the auxiliary of 2½ candle-power and 8 volts. These lamps are arranged along the sides (the roof being occupied with oil lamps), two lamps in each case, protected with strong glass covers; but in every alternate case the small auxiliary lamp was placed between the two higher voltage lamps. Each car carried a battery of 4 secondary cells for lighting the auxiliary lamps, and also a self-registering push knob for electrical communication with the guard.

The various cables and wires required for the several circuits, specially manufactured by Messrs. W. T. Glover & Co., of Salford, are carried under the vehicles, and terminate at each end in a coupler of special design; these couplers, having sufficient lengths of cable attached to them, are so designed that they can be easily connected together in the right position. Each coupler is provided with an automatic arrangement, so that in the event of the vehicle breaking away the auxiliary lamps are at once lighted. Dummy couplers are provided for attachment when the vehicles are separated. The guard's van is fitted with the necessary controlling switches and with a bell and battery for passenger communication.

The system works thus:—When the dynamo is running and lighting the high voltage lamps the auxiliary lamps are kept inactive; but when the dynamo is not running, these latter lamps can be lighted by the guard turning over the proper switch.

The auxiliary lamps, though of low candle power, give more light than the old oil lamps, and are considered quite sufficient for the lighting of the train in the daytime, when going through tunnels, or in the night when carriages are separated from the main train and put into sidings. The manner in which the system is worked, and the means by which the auxiliary cells are charged cannot properly be explained without the use of a diagram; but sufficient has been said to show the general nature of the plan; on an early occasion, however, we hope to enter more into detail of the system Mr. Timmis has designed for carrying out an efficient system of electric lighting in trains.

We may, however, express our satisfaction at the excellent results obtained by Mr. Timmis, and of the manner in which the various details have been designed and made, and the work carried out, so that the internal decorations and appearance had not been interfered with. The various tests and experiments shown were witnessed, we noticed, by representatives from the London and North Western, the Midland, the Great Western, and the Lancashire and Yorkshire Railway Companies, and by other gentlemen interested in the subject.

ELECTRIC LIGHTING PROJECTS IN BRUSSELS.

A LONG and interesting lecture, the first of a series, was delivered a few nights since at Brussels, before the Society of Engineers and Manufacturers, the subject being the study of projects of electrical transmission in Brussels. M. Van Rysselberghe was announced to explain and defend the system which he upholds. A large audience was present, among whom was M. Bruyn, Minister of Industry and Public Works, several Brussels burgomasters, and the communal councillors of the capital; a number of engineers and most of the electricians of Brussels also took part in the meeting.

M. VAN RYSSELBERGHE first set forth the position of affairs. He had offered to the authorities of Brussels ot supply the lamp of two carcels at 3½ c. per hour, and a German syndicate was preferred to him, for whose lamps 5 c. would have to be paid. The mistake of the latter was in transporting electricity long distances. The lecturer demonstrated that by establishing the formulæ which give the loss of charge, or diminution of disposable power, in a conductor of electricity, and afterwards in a water canalisation under pressure. His contention was that water was especially practical and economical, while electricity did not lend itself to transport at low price. That was why the Germans were obliged to ask 5 c. The speaker showed by calculations that electricity of all modes of energy was that of which the transport was most onerous; it was necessary that electricity should be consumed on the spot to be cheaper than gas. It was on account of electrical transport that 5 c. per lamp had to be paid in Berlin, 6 c. at La Haye, 7 c. at Havre, and 8 c. at Paris; only those places did not manufacture gas. Brussels did not wish its electricity to be cheaper than its gas, and the Administration rejected M. Van Rysselberghe, who not only offered the lamp at 3½ c., but offered the city authorities 10 per cent. of his net receipts. The whole secret of the project was to reduce to a minimum the transport of electricity, which was the cause of the expense. The Léopold quarter was offered him as a trial ground, but that was not much, and was very unfavourably chosen as regards consumption. At Berlin, by the German system, a square of a kilometre up and down, comprising 17 streets or 11 kilometres of canalisation, was lighted. Three stations were necessary at a distance of 500 metres from each other; the ground alone had cost a million-and-a-half of francs; the whole of the installations cost eight millions for 37,000 lamps, of which two-thirds at most were lighted at the same time. M. Van Rysselberghe only asked five millions for a canalisation of 50 kilometres feeding 37,500 lamps of two carcels lighted simultaneously. Strong in his calculations, the Belgian inventor said to his rivals: "Can you offer lighting at 3½ c.? If you can, I retire. If not, do not speak any longer of your economical superiority. Or, rather, will you divide the city into two zones so equal that we can make a division of them with a short straw?" The three German competitors who presented themselves six months ago were in connivance —making the play for each other, and when they became masters of the ground, they formed themselves into a syndicate. They had imposed their conditions: instead of an 18 years' concession, they required 35. M. Van Rysselberghe would accept a term of 18 years. The lecturer concluded by explaining his system, which comprised, in the first place, a water canalisation under pressure similar to those already in existence in the great ports, such as Antwerp, the working of which gave rise to no criticism. All that was necessary was a special motor to put the electrical apparatus in motion. This motor must, in the first place, have a perfect regularity in working. The clever engineer had designed a very simple engine recalling in every way the hydraulic torniquet, and working very well at high pressure. The yield of a motor of this new system installed at Antwerp attained 80 and 90 per cent. In Brussels every street would have its canalisation, in accordance with the stipulations. On one site there would be an hydraulic canalisation coming from a central station. At certain points, in the communal buildings, there would be hydraulic motors occupying little space—about four square metres—and thence would come the electric current circulating in a single district, therefore at very short distances. M. Van Rysselberghe, absolutely convinced of the merits of his project, concluded by energetically demanding that the merits of national labour should never be ignored to the profit of foreigners, who, in their newspapers—notably in the *Berliner Börsen Zeitung*—already crowed over having defeated the Belgians. After this interesting defence,

M. Bède, who, before the electricity commission nominated by the Communal Council had opposed M. Van Rysselberghe's system, explained his opposition by reproducing, in the form of a summary, the calculations already published in the *Ingénieur-Conseil*. [M. Bède is the editor of this journal.] M. Bède regretted the chauvinism of his adversary. The responsibility of the authorities of the city was great; it was necessary that they should have an installation giving every guarantee. The trials of M. Van Rysselberghe inspired no confidence in competent men, and required several years to show its benefits. In case of non-success, all that time would have been lost to the authorities of the city. It was necessary to put an end to the present *régime*. The shops and *cafés* made their own electricity and installed stations in the open thoroughfares; the authorities were losing important sums. M. Bède laughed at the mania of M. Van Rysselberghe, who always saw his rivals in Germans. These—of whom there were only two—included a Liége firm, which was absolutely Belgian, and a Berlin company, which had united in order to establish the Berlin system at Brussels. That system had excellent antecedents, whatever might be said. The company paid its shareholders 8 per cent., and had obtained the lighting of the whole city. From a scientific point of view, the principle which made it appear that electricity could not be transported economically was entirely false. When M. Van Rysselberghe presented his paper for the King's prize, the jury, which was composed of scientists, declared in its report that the calculations of the author on that point were not correct. It was undeniable that the losses would be much greater in a system in which there was a double transformation of energy. M. Bède went over the calculations afresh, and arrived at conclusions which were diametrically opposed to those of M. Van Rysselberghe. The installation of direct distribution would cost 1,300,000 francs less and the annual expenses would be reduced by 200,000 francs. One of the leading German *savants*, who had studied, detail by detail, the transmission of power to a distance, stated that transmission by water or air must be cheaper than electricity. Water was only suitable for working the machinery of a port or a railway station. When that canalisation was already in existence an endeavour might be made to apply it to lighting. That had been done at Frankfort, and had given bad results. M. Bède showed that water canalisation at a pressure of 50 atmospheres, which was extolled for Brussels, would be very dangerous; further, hydraulic motors, as well as automatic safety apparatus, inspired no confidence in the speaker. Lastly, sufficient advantages had not been shown to induce the authorities to risk the adventure. The fundamental vice of the system was a waste of energy; and they must believe that M. Van Rysselberghe had deceived himself in his calculations, or else that he wished to get a higher price for his installation on its being taken over by the authorities, or, lastly, that his system was very costly. The opinion of M. Bède was confirmed by

M. LUCIEN ANSPACH, who, speaking as a professor of mechanics, showed the dangers of water at a pressure such as in case of breakage of the conduits the speed should attain 100 metres per second. The calculations of M. Van Rysselberghe were incomplete; it was evidently electricity which it was necessary to transport; in default of that, compressed air presented more advantages than water. In a conduit of the same size, it would be sufficient to compress air to 10 atmospheres. M. Anspach, in conclusion, expressed a wish to see Belgian electricians light Brussels.

M. **FLAMACHE**, a Professor at the University of Gand, put several questions to M. Bède, especially regarding the undertaking from a ratepayer's point of view.

M. **BEDE** answered very briefly, as it was then midnight, and the discussion of the arguments pro and con. terminated by discussions of the subject between individual members.

The above lecture, as already stated, was the first of a series, and as the hour was too advanced to allow of M. Van Rysselberghe answering his various critics in detail, he was given that opportunity a few nights later, when he replied in a long and argumentative speech which may be summarised as follows: Electricity is not transportable, it must be consumed where it is produced; transport could only be effected under a very high potential, and the system would thus become dangerous. Opposition theories do not take into account the particular conditions of application when a canalisation has to be extended to a large city. The whole success of M. Van Rysselberghe's idea depended on the conception of a cheap and good regular hydraulic motor. That motor existed, worked, and had given proof of its existence. Accidents which have been ridiculously exaggerated would rarely happen and would always be without gravity. The water would escape and the pressure would be instantly destroyed, because the canalisation was only connected with a reservoir of very limited capacity. Moreover, the trials of resistance and a good laying down would guarantee the solidity of the conduits. In Antwerp and in London—where the canalisation was 56 kilomètres in length—those interested were convinced by practice of the security which the transport of motor-power by water under pressure presented. It was sufficient if the joints and unions were carefully executed and if unequal settling of the soil were prevented. Much had been said of air balls or pockets, but M. Van Rysselberghe had never thought of applying them; those pockets were not necessary. Lastly, the estimates, which had been carefully gone through, confirmed the contested price of 3½ c. per lamp hour, while giving a profit of 100 per cent. on the net cost. M. Van Rysselberghe concluded by stating that the jury for the King's prize had only declared his calculations inexact when they turned upon the working of a motor at a distance by the transport of electric power.

M. **ROYERS**, engineer to the city of Antwerp, described several water-pressure canalisations and quoted different industrial applications of that motor power. Experience had shown that accidents were rare and never had fatal consequences. As for air balls, M. Royers declared himself in accordance with M. Bède, but it was not necessary to insist upon that, since everybody was agreed as to their suppression and that they could not be practically placed.

M. **LEGRAND**, Secretary of the Society of Engineers and president of the meeting, stated that a visit of inspection would shortly be made to inspect the apparatus which was working at Antwerp.

M. Bède then spoke, and went point by point through the statements of M. Van Rysselberghe. As to accidents, no one had spoken of the principal consequence—the extinction of the whole of the lighting. M. Bède returned to his statement, and repeated that the so-called principle according to which electricity could not be economically transported was totally false. He then quoted some curious instances of the transport of electricity, and afterwards produced a closely figured-out estimate by taking his opponent's figures. M. Bède concluded by affirming 3½ c. per lamp to be an impossible price.

M. **VAN RYSSELBERGHE**, like M. Bède, admitted the accuracy of his adversary's calculations, but deduced therefrom conclusions diametrically opposite.

These estimates, starting from the same figures and arriving at contradictory results, obscured the debate, and simply perplexed the hearers while doing nothing to enlighten them. The meeting ended at midnight by a speech from an engineer who went all through the problem and demonstrated that M. Bède's theories on the transport of electricity were correct.

M. Anspach was announced to open the debate at the next meeting by comparing hydraulic transmission with high and low tension electrical transmissions.

THE ST. JAMES'S AND PALL MALL CENTRAL STATION.

THE above station, which belongs to the St. James's and Pall Mall Electric Light Company, Limited, has been erected in the middle of Mason's Yard, Duke Street, S.W. It consists of a three-storeyed fire-proof building constructed of white brick, and supported upon iron pillars and girders in the centre. This main block is used for offices and stores, but on the ground floor a battery of accumulators is being installed. The engine room and boiler house have been dug out in the basement. The station, which first commenced to supply current in April last year, is arranged on the three-wire system of distribution, and is, both from the manner in which the mechanical and electrical arrangements have been carried out and from its general condition, probably the most compact central station in the country.

In the boiler room, which has been designed to contain six boilers, there are at present five Davey-Paxman locomotive boilers built of mild steel to work at 150 lbs. pressure; they are 20 feet 5 inches long and 6 feet diameter over the barrel. The boilers stand in one line with the coal bunkers and ash hoist facing the fire-boxes, whilst at the back is the underground flue connecting to the main shaft. In one corner of the boiler room an artesian well is being bored to a depth of 380 feet, but only half this depth has yet been attained. When completed, the water from this will be pumped into an underground reservoir having a capacity of 12,000 gallons, whilst a separate supply from the town mains is available in case of need. The water from the reservoir is forced by three large Worthington pumps into two Berryman feed heaters, where the water is raised to 212° F. by the exhaust steam from the engine room, and then passed direct to the boilers. In addition to this, each boiler has an injector and cold feed from the reservoir.

The engine house is designed for 12 Willans compound central valve engines, with centrifugal governors, mounted with the dynamos on combination bed plates for direct driving. Ten of these engines will be of the I I size, working up to 210 horse-power at 350 revolutions, whilst the other two will be of the G G size, working up to 80 horse-power at 480 revolutions. The 10 large dynamos are for 1,700 lamps of 16 C.P. each, and the two small dynamos for 700 lamps of 16 C.P. each. The machines, which have drum armatures, are designed to run up to 125 volts, for battery work, and are all shunt-wound for regulation by resistance in the field circuit. At present there are only installed eight dynamos and their corresponding engines. The dynamos comprise four 200-unit Siemens machines, two 100-unit Latimer Clark dynamos and two 50-unit machines, by the same makers. As, however, the number of lights supplied does not exceed 3,500, which is being increased at the rate of about 2,000 per month, only two Siemens dynamos are now being run; but as the evening passes away, and the demand for light decreases, the two small dynamos are started and the larger machines stopped.

The steam pipes are all carried overhead, and so arranged as to prevent any possibility of serious breakdown, and are of wrought iron with copper bends. Two 9-inch pipes, connected together at the farther end of the boiler house, are carried through into the engine house. Each pipe passes round one side of the engine house, and is connected through steam separators to six engines; the two pipes are then connected across at the eastern end. By this means a complete ring, closed on itself, is formed, and by the interposition of suitable stop valves, in addition to those on each boiler and engine, no accident or leakage necessitating repair can throw more than one boiler or two engines out of gear. The exhaust pipes are carried in trenches and lagged, the exhaust being carried through the feed-heaters, or through a bye-pass as required, to the main shaft.

The main battery will comprise 240 Elwell-Parker cells of the 31 L type, ranged two cells in parallel, thus forming two series of 120 cells each across the mains. The battery will be connected up on the three-wire system, and fitted with massive regulator switches on the charge and discharge circuits at each end of the battery, the regulation extending over 14 cells. The charge and discharge will be carried through ampèremeters, the battery giving a discharge of 300 ampères at 110 volts. It will be used as a regulator to fill up the gaps between the larger machines, so that the machines may always work at an economical load, and for the night lights, thus allowing the machinery to be shut down during the small hours of the night. Two smaller dynamos will be used for charging the battery, or they can be adjusted on the regulator switches to work direct to line, but the larger machines will not be used for charging, they being connected direct to the mains.

The connections to the present switchboard from the machines consist of heavily insulated tables, carried in porcelain insulators on brackets screwed to the overhead girders, the connection being for parallel work on the 3-wire system. From the left hand terminal of each machine the cable passes through an automatic cut-out mounted on the top of the machine, which is designed to break the circuit of each machine when the current falls to about 50 ampères on shutting down. From this cut-out the cable passes to a main fuse board, a line of six main fuses being mounted on each side of the main switchboard. A collecting bar joins each set of six fuses, and these two bars are connected together and through an ampèremeter to the middle or intermediate main. The right hand terminal of each machine is connected overhead to a terminal on the main switchboard, which is of slate, measuring 9 feet 6 inches wide by 6 feet high. The main terminals connected to each machine are mounted in a horizontal line along the top of the board, and from each a heavy gunmetal bar is carried vertically down to the switch, one being arranged for each machine. On this bar is mounted a soft iron needle and scale, enclosed in a suitable box to form an ampèremeter. From the switch the connection is carried down to a heavy stud placed between two horizontal bars, which are connected through three ampèremeters apiece to the outer mains. From each of the studs placed between the two bars a heavy strap can be shifted from one bar to the other and bolted up firm, thus allowing of each machine being placed on one side or other of the 3-wire system as required.

The machines will be separately excited from the main circuits. It will be evident that in changing the machines from one side of the system to the other the currents in the armatures are reversed owing to one pole being connected permanently to the intermediate main, but the advantage of having only two omnibus bars for a 3-wire system is so great that this object has been obtained by automatically reversing the shunt connections by means of the same connecting strap on the main board. By this means one end of each shunt is connected direct to the left hand terminal of each machine, whilst the other passes through a switch mounted on the side of each machine. This switch is so designed that before breaking the field circuit it throws into parallel with the shunt coils a non-inductive resistance of equal resistance to the coils, so that on breaking the field circuit the extra current discharges harmlessly through this resistance. From the switch the wire is led to its section of the main regulator and then connected to one of the centre studs between the two main bars. Thus, in reversing the connecting strap so as to connect a machine to the right or left hand outer main, the shunt connection is reversed at the same time, so as to magnetise the field to suit the change in the direction of the current. A larger switchboard is now in course of construction, and will be so arranged that the dynamos may work on either side of the mains.

The engines are arranged to run on their centrifugal governors to obtain, as far as possible, a constant speed, the rest of the regulation being done on a specially designed regulator at the foot of the main switchboard. This regulator is formed of a skeleton frame tied together by two long horizontal angle irons and a fixed steel spindle. Across the angle irons are mounted 12 commutator sections, one for each machine, each commutator being connected to a separate resistance of 14 steps for insertion in the field magnet circuit. On the fixed spindle are 12 rocking handles carrying a bent contact piece, which makes connection on the side of each commutator and a collecting strip parallel to it. The shifting of each handle backwards or forwards puts in or cuts out resistance in that machine. Each handle is fitted with a spur wheel, and on each side of the fixed spindle is a rotating spindle. The back spindle regulates the right hand side of the mains, the front spindle the left hand side, and according as the machine is working on one side or the other of the mains the spur wheels are connected by fast and loose pinions sliding on feathers on either shaft to be worked by that shaft. At one end of the regulator two large hand wheels 15 inches in diameter work the two shafts, and in front are the two main voltmeters. The other end of the shafts are to be fitted with automatic driving gear. The regulating handle for each machine comes directly under the line of connections belonging to that machine on the main switchboard.

The principle of mains employed is the 3-wire system, the middle wire being one-half the sectional area of the other two. The cables are formed of bare copper strips, each strip measuring 2 inches wide by ·1 inch thick. The largest main in use is composed of eight such strips, or 1·6 square inch section. The system of laying is that of a ring main running round Piccadilly, Regent Street, Waterloo Place, Pall Mall, and St. James's Street. This is fed by six heavy feeders, and radial mains branch out beyond the ring. From each feeding point pilot wires are brought back to the station, so that the pressure on the ring main can be noted at six points. The mains are run in a cast iron culvert with bolted cover, the culvert joints being leaded and the covers packed with yarn and red lead. The mains are supported on porcelain insulators, and spaced by means of porcelain jockeys. At frequent intervals junction boxes are built of brick, with cast iron frame covers and stone centres. The junction boxes are drained, and the culvert, wherever possible, is laid with a fall to the junction box. Wherever a dip occurs which cannot be drained direct, a syphon box and hydrant are fitted, so that any water that may collect may be pumped out as in the case of gas mains. At any junction box the mains can be easily disconnected for testing or making connections. To do this on a live main, the connection between two sections is first shunted by two copper clips joined by an insulated flexible wire, the connection is then broken, and the clips snapped off, thus severing the main. The house connections are made with vulcanised cable, run in gas barrel, tapped into the bottom of the culvert and secured by back nuts, and carried through to the company's switch-box in the house.

The company does not undertake house wiring, but has issued a set of rules for the use of contractors, and all work is inspected and tested before passing, and a high standard of insulation maintained. The pressure is kept constant at 107 volts on the ring main, and all houses on this main use 106 volt lamps. The voltage is raised to 108 in those houses near to the station, and reduced to 104 in those furthest away.

The station, which will shortly be in full operation, will have a capacity of 16,000 16-C.P. lamps, with ample reserve, and since its inauguration there has not been a single failure in the supply of current. The chief subscribers are the clubs in the neighbourhood.

THE BROOKLYN SUBWAYS.*

Final Report of the Commission—Interesting Review of the Underground and other Wire Work in Brooklyn.

(*Concluded from page* 187.)

General Superintendent Reilly, of the same company, also submits a report to the board in which he says :—

"Terminating either an underground cable, or a cable placed upon the elevated railway structure itself at some convenient point on the road, we run rubber covered wires from that point in a distributing box, 6 inches square, which is placed along the footway between the tracks, to the points opposite where it is desired to branch them off. The wires are then dropped through holes in the bottom of the box, run along the cross girder of the road to the curb line, and jumped directly into the subscribers offices or to a branch pole line or house top fixture. Where there is a group of subscribers in a block it is the practice to branch a cable containing 10 to 25 conductors from the main cable on the road to a convenient point in the block, and distribute over housetops from there.

"We had decided to place some 30 miles of conference standard cable in our underground conduits and upon the elevated railroad structures during the year, but we were fortunate in perfecting and applying a very simple and effective method of transpositions, which enabled us to reduce our cable purchases one-half. . . .

"Close observation of the creosoted conduit and the lead covered cables, laid at various times since 1884, seems to prove that the destructive agent usually present in freshly creosoted wood disappears almost entirely after a few years.

"A Western electric cable, purchased in 1886, and placed in the 1884 conduit during 1887, over two years ago, shows but very slight trace of action on its surface at this date, while part of the same cable laid in the 1881 conduit shows quite a scale of carbonate of lead after one year's exposure. Parts of the same cable placed in other conduits about a year after their construction show but little damage on the surface.

"A Western Electric cable placed by the Metropolitan Company late in 1885 in a creosoted conduit between the Brooklyn central office and the Brooklyn bridge, when examined a few days since, after three and a half years' exposure, shows a slight crust of carbonate, principally on the upper part. A. N.Y. and N.J. cable laid in the same conduit in 1886 is in the same condition. We do not anticipate the loss of either of these cables from the action of gases. To further test the effect of time and ventilation on creosoted wood, we placed samples of the Western Electric and N.Y. and N.J. cables covered with the alloy of tin and lead in a box made of creosoted wood, which had been on hand in the yard for two years or more, and samples of the same cables in a box made of creosoted wood which had been on hand about eight months.

"After being sealed up for three months the boxes were opened, and the samples in the old wood box were found to have but infrequent patches of what is known chemically as phenolate, while the samples in the box made of the later lot of wood were thickly covered on the sides and top by phenolate. Either phenol, a volatile gas, or acetic acid in combination with carbonic acid gas will reduce lead to carbonate of lead. There being no acetic acid in the wood properly treated with dead oil of coal tar, and the phenol escaping by evaporation and ventilation, the carbonic acid gas present will in all probability have no more effect on the lead covering than if the cables placed were in ducts of iron or other material. It would seem desirable, therefore, before placing creosoted conduits underground, to expose them to the air or to artificial means for evaporating the phenol from the creosote, if the latter cannot be obtained free from it. There seems to be no doubt as to the durability of creosoted wood. Frequent examinations during the past five years show there is no decay of the wood or change of any kind to cause injury in placing or removing cables. Its economy, flexibility and safety strongly recommend its use for conduits.

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* New York *Electrical Review*.

"Our examination of the cables in use seems to show that there is a difference in the alloy covering. The Western electric cable, covered with the alloy of lead and tin, placed January, 1885, in a conduit completed the previous month, is to all appearances in as good a condition as when first laid nearly five years ago. It will be remembered, the cables covered with pure lead were destroyed and removed from this conduit.

"A Western electric cable, supposed to be covered with this alloy, purchased in 1886, and placed in the conduit in 1887 with cable referred to above, shows a slight trace of carbonate, while part of the same cable, placed in a newly-laid conduit, is severely attacked, as stated in remarks on conduits. The cable first referred to above is, in fact, the only one we have which can be said to show no action on its surface. We are now having chemical tests made on specimens of several cables, to determine, if possible, the difference in their composition.

"The practice of ventilating the conduits and manholes, as they are constructed, by lateral branches to poles and housetops, and to which we ascribe our freedom from explosions, have been extended considerably during the past year by placing 3-inch iron pipes from manholes to the columns of the elevated railroad, which serve the double purpose of ducts and ventilators. The quantity of gas in conduits and manholes has been sensibly reduced, and in two instances where conduits entered central office basement, the odour of gas, which it seemed impossible to entirely exclude, disappeared entirely after the manholes were connected to the elevated railroad structure by a number of 3-inch pipes. A large tube leading to a dead chimney at this office, in connection with pipes to elevated railroads near by, usually keeps the large tunnel through which the conduits enter the building pretty free from gas.

"We believe ventilation of this kind is the easiest and best method of preventing the explosions in manholes occasionally reported from other cities.

"Experience confirms our belief that manholes should be made large and roomy, with hooks or guides on the sides where cables and junction boxes may be arranged out of the way of workmen engaged in drawing cables in and out.

"Except the cables removed on account of destruction of the lead covering, we have had no special trouble with either cables or terminals, and the electrical condition of our cables remains practically as reported last year. All cables connected during this year give satisfactory results in insulation and capacity."

THE OPINION OF THE ATTORNEY OF THE BOARD.

Mr. James McKeen, the counsel of the Subway Board, in an interesting opinion on the present situation, says:—

"Section 6 of the law of 1885 provided that the term of office of the commissioners should expire on the first day of November, 1887, or sooner upon the performance of their functions. By an amendment to the Act, passed in 1887, it was provided that the terms of office of the Brooklyn Commissioners should extend until November 1st, 1889, unless their functions should have been performed sooner. Although the Act, as amended, did not in terms fix the limit of the duration of the board itself, and although the provisions of Section 6 of the Act suggest its continuance by providing that the Governor should have power to appoint successors, there is no room whatever for doubt, taking the whole Act together, particularly the provisions of Section 9, that the life of the board as such becomes extinct with the expiration of your present terms of office. . . .

"The condition which will result from the expiration of your term of office is one full of perplexity. As you are aware, in accordance with your instructions, I called the attention of the city authorities early last winter to the importance of such legislation as would enable the work to be continued. It was suggested by me that the duties of the Commissioners under the Subway Acts might be devolved upon some branch of the city government. It was, however, thought by the Mayor wiser that the life of the board itself be continued, and a Bill was introduced at the request of the Corporation counsel extending the life of the board and giving the Mayor power to appoint successors. This Bill failed on its final passage through the Senate, chiefly owing to the opposition of Mr. Senator Worth. It was then too late to pass any alternative measure. The existing situation will no doubt compel further legislation at an early day. My own judgment is that a separate department or bureau should be created in the city government, looking to a permanent control of electrical conductors in the city.

"The Act of 1884 imperatively requires that all electrical conductors shall be placed under the surface, and that Act required the local government of the city to remove, after November 1st, 1885, all telegraph and electric light cables and poles wherever found above ground within the corporate limits. This Act remains unrepealed, except so far as it is inconsistent with the provisions of the Act of 1885. The main purpose of the Act of 1885 was to create a commission who should solve the scientific difficulties supposed to exist, should devise under certain limitations a general plan and system of underground subways and compel the electrical corporations to use them, the commissioners having power to grant deviations from underground systems and allow aerial wires to be used in certain cases and contingencies. It is very obvious that the Legislature in 1885 had no conception of the extent of the work which would be required fully to carry out an underground system. As has already been shown in your own very full reports, it has been impossible under the limitations of your powers in the act, to devise and successfully put in operation a plan which would include the high tension and alternating currents in the subways adapted to ordinary telegraph and telephone wires. The Legislature in 1885, perhaps, had no reason to anticipate the enormous extent of the business involving the use of electrical conductors in cities. Moreover, companies operating the telegraph have certain rights to the use of streets by virtue of the general act under which they are incorporated. They are general servants of the public *as carriers of messages.*

"The various companies distributing electricity for purpose of light and power are in a different category. They have no rights, by virtue of their corporation, to the use of the public streets for their conductors, either above ground or under ground. They have had recourse to the city government to obtain franchises for their businesses, but after obtaining such franchises they continue to be subject to the provisions of the subway acts to the same extent as telegraph companies.

"At an early stage in the life of your board the question arose as to the continuance above ground of the wires used for arc lighting. The question was at that time referred to the learned corporation counsel, whose opinion was that until a subway should have been devised and prepared, in which these wires could be operated, they should be permitted to continue. I have had no occasion to dissent from the opinion in the matter of the corporation counsel, but I have not construed it as a warrant for the indefinite extension and continuance of the overhead electrical couductors. The city officials, however, have, I believe, allowed these to be extended, without any permits from your commission, construing such extensions to be within the terms of the various franchises conferred by the Common Council upon these companies. In view of the expiration of the commission there would seem to be, after November 1st, no board or department of the city government having power to permit aerial wires. I am unable to discover how they can be lawfully extended or maintained except in accordance with such permits for deviations from underground systems as may have been granted by you. It would seem that the duty becomes again affirmatively developed upon the local government of the city to remove them, wherever found above ground within the corporate limits. In short, it seems to me that the object of the creation of the commission by the Act of 1885 was to enable all companies authorised to use electrical conductors in the city to get their conductors underground with the aid and approval of the board, they having the right, in certain specified cases, to deviate from an underground system where that was discovered by the board to be impracticable. If companies themselves have been unable to devise and get in operation a successful underground system, and have failed to procure from the board the requisite permission to deviate from such a system, it would appear to be their misfortune."

The concluding report is from the inspector of the board, who describes the routes and wiring of the Municipal Electric Light Company of Brooklyn, and of the Citizens' Electric Illuminating Company of the same city.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(*Concluded from page* 190.)

IN some types of machines made in the United States a series coil is wound round the armature instead of on the field magnets. It is then sometimes wound obliquely so that it lies against the two trailing pole corners. The idea in arranging it obliquely is, no doubt, to counterbalance the obliquity due to the armature current in some way. If the series coil is wound on the armature, it must have enough ampère-turns to counterbalance the back current-turns on the armature, and, in addition to this, enough to increase the armature induction enough to allow for the armature resistance at full load. In a large machine, therefore, it is equal to but little more than the back current-turns. As it is arranged obliquely it also counteracts part of the cross current-turns; but as the cross current-turns are always much more numerous than the back current-turns, the series coil in this position lessens the cross induction to a very small extent. This arrangement has therefore little advantage.

As a very weak field is enough to reverse the current in a section, a small pole-piece might be so applied to the armature as to reverse the sections at any convenient place. If the reversal could take place in such a position that the brushes would have a negative lead, the back current-turns would be converted into forward current-turns, and a machine could be designed to give constant electromotive force, or even a higher electromotive force at full load, without any series winding on the magnets at all. Reversing pole-pieces, as they are called, were brought out some two years ago. Fig. 10 shows a simple case. Two reversing pole-pieces are shown. In order that there may be some induction in the same direction as that in the left limb of the magnet, it is clear that the line integral of the magnetic force from A to B must be positive. If the brushes are under these reversing pole-pieces the line, A B, passes through the neutral points, and the cross potential is $\pi n c/10$. Each reversing magnet must therefore have $\frac{1}{3} n c$ ampère-turns on it to counteract the cross current-turns, and a few more to cause the reversal. In large machines these pole-pieces are thus difficult to work in.

In a drum armature it would not be necessary to have two reversing poles; one wound with a little more than $\frac{1}{3} n c$ ampère-turns would be enough. Of course these poles should have their coils in series with the armature, so that their excitation varies with the cross current-turns.

If the reversing pole-piece, A, is made larger, and attached to the yoke, the same number of current-turns is necessary, as the yoke is at the same magnetic potential as the centre of the armature, if the magnet limbs have equal coils, and the left pole-piece is not highly magnetised. As the reversing pole needs no excitation at no load, the shunt must be wound on both limbs equally. But the series coils may all be wound on one limb so that the yoke is not at the same potential as the centre of the armature at full load. Suppose the series coil has $n c/16$ ampère-turns on each former, with no reversing pole-pieces, the whole may be put on one former, and the reversing pole-piece then requires but little wire on it. But the reversing pole-piece does away with the need of much series winding on the fields, so there would not be anything like these series current-turns to be arranged at pleasure; in fact, if the reversing pole-piece were put on one side, so as to give negative lead to the brushes, there would be no need of any; and for this reason the reversing pole-piece is, in large machines at least, somewhat impracticable.

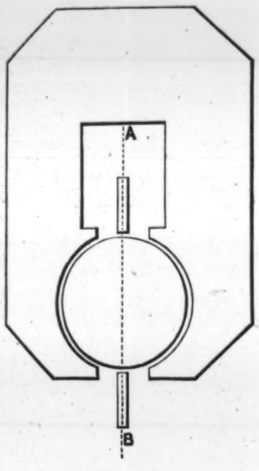


FIG. 10.

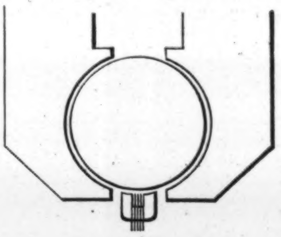
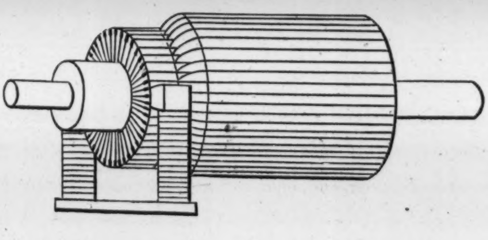


FIG. 11.

Fig. 11 shows an arrangement in which a small horseshoe electro-magnet is arranged against the uncovered part of an armature. The horseshoe, as a whole, provides a convenient path for the line of induction due to the cross ampère-turns. If the electro-magnet has more ampère turns on it than there are on the part of the armature covered by it, one pole of it will act as a reversing pole piece. This electro-magnet is a little difficult to attach to the dynamo so as not to cause excessive magnetic leakage, as the sides of it come near the main poles of the dynamo.

FIG. 12.



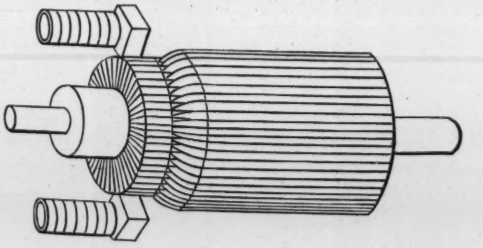


FIG. 13.

Fig. 12 is a diagram of another method. The armature proper is made as usual, but the connections to the commutator pass over the outside of a sort of subsidiary armature core. The electromotive force needed for reversing a section is induced in the connection by a subsidiary field magnet with narrow pole pieces, as shown. The little field magnets are wound in series with the main circuit. The connections are shown embedded in the core as in the notches of a Pacinotti armature. A small yoke is shown in fig. 12; in practice, the subsidiary magnets would be mounted on the bed plate.

Fig. 13 shows an arrangement in which the subsidiary magnets are mounted on the rocker that holds the brushes, so that the machine can be regulated by moving the brushes backwards or forwards without producing sparking.

It is probable that some form of reversing pole piece will come into general use, so these forms are described at length.

The advantages to be gained by such an arrangement are very great. The brushes do not need to be shifted as the load varies, which saves attendance and wear. Back current turns are avoided, and this reduces the expense in the series field windings, and saves power now wasted in them. The field magnets can be made smaller, and the induction in them will be the same at full load as at no load, so that the electromotive force will not be unstable at light loads—a state of things which is not always avoidable at present.

A smooth surface commutator, such as is generally used in low tension dynamos, is seldom used on machines for arc lighting. No doubt the reason is this: An arc light machine must be series wound, because it would be too expensive to wind the field magnets with small enough wire to act as a shunt. Though series-wound, it must be arranged so that any increase of current is accompanied by a decrease in the electromotive force, or the lamps would flicker. The point of no sparking, therefore, shifts forward when the current increases, and backwards if the current decreases. There must be a large number of turns per section, so that the least movement of the non-sparking point causes sparking at the brushes. If the current of the machine increases above the normal, so that the brushes are no longer far enough forward to avoid sparking, the spark caused remains as a small arc till the current in the conductors of the section comes to the normal, and then disappears. If the machine current falls below the normal, the current in the section will have increased beyond the armature current, and the arc so formed may continue long enough to burn the commutator sections, or even to flash round. In machines with very few commutator sections the brushes are always given too little lead, otherwise there would be a flash round every time the current fell below the normal. No doubt this is why the practice in arc light machines is to use few commutator sections, to leave a small air space between them, and to give the brushes less than sparkless lead, so that the sparks then form between the end of the brush and the edge of the section, and do not destroy the surface of the commutator, and do not flash round. In spite of this, however, arc light machines have been made for some time with continuous surface commutators.

GRAMME AND DRUM ARMATURES.

The drum armature was invented by Worms de Romilly, and in 1872 an account was published in *Les Mondes*.

First, as to winding. If a given armature is wound Gramme or drum, with a given number of external turns, there is less resistance in the drum, unless the armature is of very large diameter in proportion to its length. If the discs are made specially for a drum armature, a greater radial depth can be allowed, as the space used for inside turns in the Gramme can be utilised for iron.

If the radial depth of the disc is greater, and the induction in the iron of the armature is the same, the induction in the air gap is greater. This takes heavier field magnets and more excitation, but increases the output of the armature. In addition to this it admits of more armature current turns, as the cross induction can be increased also without reversing the induction under the leading pole corners. With a drum armature a very much larger single-magnet machine can therefore be built than with a Gramme.

Each section of the Gramme machine has a higher resistance than that of a drum with the same number of commutator sections. If a given armature is wound Gramme instead of drum, the self-induction is about double for each external turn, because the conductor also makes a little field of its own inside the armature, as in fig. 3, being close to the iron, and the self-induction due to that would be about equal to that of the active part of the conductor. Two turns per section make the self-induction from three to four times as great as it would be with one turn. There is no mutual induction between the conductors in connection with the opposite brushes, as in a drum machine, so the self-induction in the Gramme may be taken as twice that of the drum. The Gramme may, however, be made with twice as many commutator sections, giving one turn per section. The self-induction of a section is thus greater then the self and mutual induction of half a convolution in the drum, and the resistance is also greater. The Gramme, therefore, still requires a stronger reversing field. The effect of this is that a small displacement of the brushes—or, what is the same thing, a small variation of the load—causes a greater spark at the tip of the brush. If the armature is perfectly symmetrically made a position of no sparking can be found for any given load with a large number of turns per section, but the least variation of load or movement of the brushes will then give rise to sparking.

The Gramme has still another great disadvantage when used in large machines. The current turns on the armature bring the sides of the internal hole to a considerable difference of magnetic potential, and this causes induction in the spindle, and heats it. This not only causes waste of power, but frequently the heat is conducted to the bearings and initiates hot bearings in addition. In a drum armature the sides of the inside hole have only a difference of potential of l_a B $/\mu_a$, as the armature current turns do not affect the spindle. The armature can generally be made of such radial depth that it is slightly magnetised, while a Gramme armature is generally taken up as high as consistent with keeping cool and economy of field wire. The induction due to the back turns in the central hole in a Gramme machine introduces a correction in the size of magnet iron, as it acts as waste field. The induction in the hole is really oblique, and is due to the whole of the armature current turns, so that the leakage is often very serious.

The drawbacks to the drum armature are all mechanical. In small drums the difficulty of winding, the want of ventilation at the ends, and the difficulty and expense of repair, more than balance the advantages of small resistance and little wire, or large output.

In large machines the same drawbacks appear, but they are of less relative importance. Without doubt, the large dynamo of the future will be a four-pole or six-pole drum. By using four poles a much larger machine can be made without trouble from cross induction. The end connections, which are the greatest difficulty, then become much simpler, and any part of any convolution can be taken out for repair without disturbing the rest of the conductors. The central ventilation hole is much larger, as the radial depth need only be half what it is in a twofold machine.

RELATION OF MOTORS TO DYNAMOS.

Having discussed the full theory of dynamos, its application to motors is, of course, exceedingly simple. A motor is nothing but a dynamo running the other way, as a dynamo is a practically reversible machine.

Fig. 14 shows a dynamo armature with the position of the brushes and the back and cross armature windings. For simplicity the brushes are shown as touching the outside of the armature instead of the commutator.

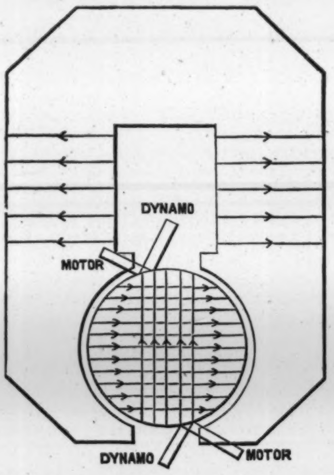


FIG. 14.

Suppose the direction of the currents in the field and armature to remain the same, but the direction of rotation of the armature to reverse, the dynamo then becomes a motor. The brushes must be inclined the other way, as shown dotted, otherwise the ends would catch in the commutator. The cross and back turns remain as before, so that the armature current opposes the field excitation. The brushes would be in exactly the same place in the motor as in the dynamo if the field where the commutation takes place were uniform. As a matter of fact, it is stronger near the pole corner, so a motor has a very little less lead. It has sometimes been said that the armature current assists the field in a motor, but this can only take place if the brushes are given a negative lead. The same result is obtained in a dynamo by putting the brushes back; but in both cases, of course, this leads to excessive sparking. It is sometimes imagined that some effect of the convolutions being commutated acts differently in a motor, but a glance at the diagram shows that the action is completely reversed. The section being commutated in a dynamo, opposes the movement of the armature; in a motor it assists the armature. No appreciable Foucault currents can be caused by the reversal of the section. If any were, they would assist the dynamo and oppose the motor, so that they would also be reversible.

Most writers on dynamos speak of loss of electromotive force and loss of power by "self-induction of the armature." This is often supposed to amount to about 5 per cent. or 10 per cent. There must be some misunderstanding about this, as there is no way in which such a loss could take place. The current in the armature is sensibly constant except in the section being commutated. In any case, power cannot be lost by self-induction.

There is, then, no point in which the dynamo is not perfectly reversible, except a merely theoretical difference in the position of the brushes, and there is no foundation for the idea that a motor should have a large armature and a weak field. In so far as any motor departs from the design of a good dynamo it is bad.

Of course, the winding of the field magnets in a motor is different.

The winding and design of magnets of motors has received but little attention. Suppose a motor is to run at constant speed on a constant potential circuit. The shunt excitation is

$$\Omega_s = l_a \, \mathrm{B}_{ao}/\mu_o + g \, \mathrm{B}_{go} + l_m \, \mathrm{B}_{mo}/\mu,$$

the suffixes *o* and *f* showing reference to full or no load.

At full load the armature induction must be reduced so that the full load current passes. If E is the terminal electromotive force, and R the armature resistance, the armature induction at full load $\mathrm{B}_{af} = \mathrm{B}_{ao} \dfrac{\mathrm{E} - \mathrm{C\,R}}{\mathrm{E}}$, and the gap induction is also reduced in the same proportion. The full load magnetic potential of the field coils is

$$\Omega_{s+m} = l_a \, \mathrm{B}_{af}/\mu_a + (\pi - \theta) \, n \, \mathrm{C}/10 + g \, \mathrm{B}_{gf} + l_m \, \mathrm{B}_m/\mu_m \qquad (8)$$

The alteration of the first and last terms makes so little difference to the value of Ω_{m+s} or Ω_s that it may be disregarded. The full load excitation is thus increased by $(\pi - \theta) \, n \, \mathrm{C}/10$, and decreased by the difference between $2 \, g \, \mathrm{B}_{go}$ and $2 \, g \, \mathrm{B}_{gf}$. That is to say, extra field excitation is needed to counteract the back current turns on the armature, and less excitation is needed to produce the reduced air gap induction. If these are equal, the machine will keep constant speed when shunt wound. In a small or slow machine the armature loss is large; in a large one the back induction is great. A small machine, therefore, needs backward wound series coils, and a large one forward wound. If $(\pi - \theta) \, n \, \mathrm{C}/10 = g \, \mathrm{B}_{go} - g \, \mathrm{B}_{gf}$, the shunt ampère turns needed at no load and full load differ only by the difference of excitation needed to magnetise the iron of the field magnets and armature. Unless the machine is very small, the difference in the armature and field induction is not important. It tends to make the motor run slower at full load, and this may be taken into account where very exact work is needed.

As the field induction in a motor is highest at no load, the area of cross section is

$$'\mathrm{A} = 2 \, a \, b \, \frac{\mathrm{B}_a}{\mathrm{B}_m} + \frac{r \, \Omega_p}{\mathrm{M} \, \mathrm{B}_m} \qquad (2)$$

it is thus somewhat smaller than in the case of the corresponding compound-wound dynamo.

As a shunt machine is simpler to make than a compound, and as a differentially wound motor may start backwards, shunt winding is preferable. Within wide limits of size constant speed motors can be designed with simple shunt winding. All that is needed is to make Ω_b equal to $g \, \mathrm{B}_{go} - g \, \mathrm{B}_{gf}$. $\Omega_b = (\pi - \theta) \, n \, \mathrm{C}/10$, and $\mathrm{B}_g = \dfrac{2 \, a \, b \, \mathrm{B}_a \, \pi}{(a + d) \, (r + \frac{1}{2} g) \, \theta}$, where d is an allowance for fringe, and θ is also made a little large to allow for fringe. This gives.

$$\pi \, \theta - \theta^2 = \frac{20 \, a \, b \, \mathrm{B}_a \, \pi}{(a + d) \, (r + \frac{1}{4} g) \, n \, \mathrm{C}} \qquad (10)$$

This appears complicated, but when the symbols are replaced by numbers for an actual machine, of course it is quite simple. It will be found that in very small motors this makes the pole angle too small, while in large machines the pole pieces would embrace the armature so much as to cause excessive magnetic leakage and reversed induction under the trailing corner, unless the pole pieces are designed to obviate this.

A properly designed direct current motor has also the very convenient property of running at approximately constant speed, even if the electromotive force on it varies. If the field and armature are not highly magnetised the armature induction varies approximately as the electromotive force on the shunt. The armature induction, and, consequently, back electromotive force, of the machine thus varies as the electromotive force on the mains, which is just the condition wanted for constant speed. A direct current motor will therefore preserve approximately constant speed, not only with varying load, but also with varying electromotive force.

SMALL AIR SPACE DYNAMOS.

There is a type of machine that has not yet been much studied; that is, the dynamo or motor in which the gap is kept small, being merely a mechanical clearance to allow the armature to rotate.

Obviously, as the air space is small, the magnets will need very little excitation, and there will be no waste field to speak of; so the magnets may be made exceedingly small and light, though that does not appear to have been generally realised. The Pacinotti is the best known form of this machine, the Brush being a good example. The drawback to the Pacinotti armature is that it gives rise to Foucault currents in the field magnets, and for that reason it is not generally used now, though the difficulty is sometimes overcome by making the teeth small and numerous.

Machines with the armature wires wound through holes near the periphery have been made on the Continent, but apparently with the view of increasing the armature induction by reducing the air space. This form, however, admits of very small field magnets with very little excitation, so that it is specially adapted for machines where extreme lightness is needed.

At full load, however, a trouble arises in small gap machines. As the air space is very small, the cross induction is very great, and so the induction under the leading pole corner is reversed. Of course there is a position of the brushes with no sparking, but it is very far forward, more especially if the speed is very slow, as the self-induction of each armature section is then considerable. The result is that the back current turns are very great, and so the field magnets necessary for full load are not so very small after all. If the dynamo is running at a very slow speed—such, for instance, as a motor on a tramcar at 200 or 300 revolutions—the brushes may be allowed to spark, as the sparking will be small, and given no lead, or just enough to preserve constant speed. This form of machine is suitable for the application of reversing pole pieces. It was shown that in any ordinary machine the difficulty of designing reversing pole pieces arises from the difference of magnetic potential between the pole pieces and the armature. In this machine the difference is very small, so reversing pole pieces can easily be applied.

In the case of the Brush machine the cross induction is enormous, and the back current turns are therefore enormous too. The result of this is that the lead of the brushes is very great. Such a machine may be short circuited without any dangerous increase of current. In fact, it has been used for charging batteries for train lighting at varying speeds. As the speed increases the current tends to increase, and reduces the armature induction enough to keep the current within safe limits, even if the speed is increased several fold.

The excessive heating of the trailing pole corner in the Brush machine has given rise to many speculations. It has generally been assumed that the heat generated there is no greater than at the leading pole corner, but that it is additionally heated by the hot air from the armature. It is more probable that the excessive heating is due chiefly to increased Foucault currents. As the brushes have considerable lead, the coil leaving the trailing corner is not in parallel with the other, so that the heating by Foucault currents in the trailing corner would be nearly four times as great as under the leading corner where two coils are in parallel. The iron is probably too highly magnetised to allow the induction to vary quite so much as this, and as it is cast iron, the resistance prevents the heating being still greater. The trailing corner is also very highly magnetised, while the leading probably has its magnetism slightly reversed. The heating from variation of magnetisation at the trailing pole corner is thus much greater, especially when the enormous magnetic force is considered, and the frequent passage of the armature notches. A 40-lighter has something like 120 per second.

As a Brush machine has very little air space, the shunt is very small, so that the compound machine is chiefly wound with series wire.

CORRECTION IN TESTING GRAMME MACHINES.

In the method of testing machines by running them as motors at no load, the machine is run as a motor with the armature induction the same as at full load. The power taken to drive it gives the stray power, *i.e.*, the loss of conversion. To this is added the loss by resistance in the armature and fields, and the efficiency of the dynamo or motor is thus calculated. The stray power consists of loss by mechanical friction, the loss by reversal of magnetisation, and loss by Foucault currents, and it has been assumed that these remain constant if the armature induction is constant. The theory of armature reaction, however, points to a few corrections. The loss by Foucault currents in the armature conductors is greater at full load than no load, by at most 33 per cent. The loss by reversal of magnetisation may also be slightly greater, as the induction in some parts of the armature may be greater. The loss by Foucault currents in the discs is slightly greater, but as this loss is exceedingly small, that does not matter. These increased losses are of little more than theoretical importance, but it is as well to point them out. If the machine is a large Gramme, the heating in the centre is largely increased at full load, so this method of testing does rot give perfectly reliable results in the case of such large machines. For small machines and large drum machines it is very convenient.

This paper has been devoted to direct current dynamos, as the corresponding treatment of alternating current machines is perhaps hardly ripe for discussion yet, though it is of enormous importance, as the whole theory of running machines in parallel, and of alternating motors, depends upon it.

WIRE GAUGE AND AMPERAGE TABLE.

The following extract from Prof. Silvanus Thompson's Cantor Lectures on the "Electro-magnet" will prove of service to our readers.

Dimensions.					Permissible Amperage, Probable Heating, and Permissible Depth.											
S.W.G.	Diam. (inch.)	Section sq. inch (bare.)	Turns to 1 linear inch (covered).	Turns per square inch (covered).	At 1,000 Amps. to square inch.			At 2,000 Amps. to square inch.			At 3,000 Amps. to square inch.			At 4,000 Amps. to square inch.		
					A	F	D	A	F	D	A	F	D	A	F	D
22	·028	·00062	23·81	624·	·616	2·28	4·5	1·23	9·12	1·13	1·85	20·52	·50	2·46	36·5	·28
20	·036	·0010	20·00	440·	1·018	3·18	3·9	2·036	12·72	·97	3·05	28·62	·43	4·07	50·9	·24
19	·040	·0012	18 52	377·	1·26	3·56	3·6	2·52	14·24	·92	3·78	32·04	·41	5·04	57·0	·23
18	·048	·0018	16·13	286·	1·81	4·64	3·3	3·62	18·56	·83	5·43	41·76	·37	7·24	74·2	·21
17	·056	·0024	14·28	224·	2·4	5·47	3·2	4·8	21·9	·79	7·2	49·2	·35	9·6	87·5	·19
16	·064	·0032	12·83	181·	3·2	6 57	3 0	6·4	26·3	·74	9·6	59·1	·33	12·8	105·1	·18
15	·072	·0040	11·63	149·	4·0	7·40	2·9	8·0	29·6	·72	12·0	66·6	·32	16·0	118·4	·17
14	·080	·0050	10·64	124·	5·0	8·46	2·8	10·0	33·8	·70	15·0	76·3	·31	20·0	135·4	·17
13	·092	·0060	9·44	98·2	6·6	9·97	2·7	13·2	39·9	·67	19·8	89·7	·30	26·4	159·5	·16
12	·104	·0085	8·48	79 1	8·5	11·53	2·6	17·0	46·1	·65	25·5	103·8	·29	34·0	184·4	·16
11	·116	·0105	7·69	65·0	10·5	12·8	2·5	21·0	51·2	·63	31·5	115·2	·28	42·0	204·8	·16
10	·128	·0128	7·04	54·5	12·8	14·3	2·4	25·6	57·2	·61	38·4	128·7	·27	51·2	228·8	·15
9	·144	·0163	6·33	44·1	16·3	16·4	2·4	32·6	65·6	·60	48·9	147·6	·27	65·2	262·4	·15
8	·160	·0201	5·74	36·3	20·1	18·4	2·3	40·2	73·6	·59	60·3	165·6	·26	80·4	294·4	·15
7	·176	·0243	5·26	30·4	24·3	20·4	2·3	48·6	81·6	·58	72·9	183·6	·26	97·2	326·4	·15
Stranded.																
7/22	0·84	·0043	9·62	101·8	4·3	6·73	4·0	8·6	26·9	·99	12·9	24 6	·44	17·2	107·7	·25
7/20	·108	·0072	7·81	67·1	7·13	8·94	3·7	14·3	35·7	·92	21·4	80·5	·48	28·5	143 0	·23
7/18	·144	·0128	6·09	40·8	12 7	12·4	3·4	25·4	49·6	·83	38·1	111·6	·39	50·8	198 4	·21
7/16	·192	·0229	5·10	28·6	22·9	17·2	3·2	45·8	68·7	·79	68·7	154·5	·35	91·6	274 7	·20
7/15	·216	·0289	4·27	20·1	28·9	19·5	3·1	57·8	78·0	·78	86·7	175·4	·34	115·6	311·8	·20
7/14	·240	·0356	3·87	16·5	35·6	21·8	3·1	71·2	87·1	·76	106·8	195·9	·34	142·4	348·3	·19
7/13	·276	·0462	3·38	12·6	46·2	24·7	3·0	92·4	98·8	·74	138·6	222·3	·33	184·8	395·2	·19
7/12	·312	·0595	3·01	9·97	59·5	28·5	2 9	179·0	114·0	·72	178·5	256·5	·32	238·0	456·	·18

Figures in columns marked A signify number of ampères that the wire carries.

Figures in columns marked F signify number of degrees (Fahrenheit) that the coil will warm up if there is only one layer of wire, and on the assumption that the heat is radiated only from the outer surface of the coil; they are calculated by the following modification of Forbes's rule:—

Rise in temperature (Fahrenheit degrees)
= 225 × number of watts lost per square inch.
= 159 × sectional area × number of turns to 1 inch (at 1,000 ampères per square inch).

Figures in columns marked D are the depths in inches to which wire may be wound if 1 watt be lost by each square inch of radiating surface, the outside radiating surface of the bobbin being only considered.

Rule for calculating a 7-strand cable:—Diameter of cable = 1·134 × diameter of equivalent round wire.

Figures under heading "Turns to 1 linear inch" are calculated for cotton-covered wires of average thicknesses of coverings used for the different gauges, viz., 14 mils. additional diameter on round wires (from No. 22), and 20 mils. on stranded or square wire.

Figures under heading "Turns per square inch" are calculated from preceding, allowing 10 per cent. for bedding of layers.

Resistance (ohms) of coil of copper wire, occupying v cubic inches of coil space, and of which the gauge is d mils. uncovered, and D mils. covered, may be approximately calculated by the rule:—

$$\text{ohms} = 960700 \frac{v}{D^2\, d^2}$$

The data respecting sizes of wires of various gauges are kindly furnished by the London Electric Wire Company.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888

16852. "Improvements in apparatus designed for use in connection with variable electric currents, the said improvements being also applicable to alternate current motors." W. T. Goolden, L. B. Atkinson, and S. C. G. Gold. Dated November 20. 8d. Consists of one or more primary and secondary electric circuits having a variable magnetic circuit or circuits, so that the primary circuit or circuits, being closed on the source of current, and the secondary circuit or circuits being closed through lamps, or other current-absorbing circuits, it is possible, without opening or closing any circuits, to produce currents in any of the secondary circuits as required, by varying the position of the magnetic circuit so as to divert the lines of force from any secondary circuit or circuits, in which current is not required, to any other circuit or circuits in which current is required. 4 claims.

18450. "Improvements in dynamo-electric machines and electric motors." J. Y. Johnson. (Communicated from abroad by C. S. Bradley, of America.) Dated December 18. 11d. The armature core is, according to this invention, constructed so that it reaches out so as to almost touch the pole pieces, and the copper conductors or windings are sunk in grooves formed lengthwise in the periphery of the core, such grooves being of greater depth than width, and the grooves of less width than the intervening projections of iron which stand between groove and groove. By this construction a machine is produced in which the magnetic circuits are as nearly complete and unbroken as possible, the only break being the small clearance necessary for the rotation of the armature. By properly proportioning the iron ribs left between the grooves on the iron drum of the armature, eddying or local currents in the bars can be to a large extent prevented. 10 claims.

18812. "Improved method and apparatus for the distribution of electricity by means of alternating currents of electricity in conjunction with electrical storage." R. F. Yorke. Dated December 24. 8d. Claims:—1. The method of regulation and maintenance of a uniform potential in an alternating circuit by one or more storage stations of accumulators charged from or discharging into the main circuit as required by transforming apparatus, substantially as described. 2. In such a method of storage regulation the combination of an alternator, a coupled dynamo, and an accumulator, the alternating motor and dynamo charging or receiving discharge from the accumulator, the field magnets being weakened or strengthened automatically by compounding or by hand regulation of the resistance, in order to control the rate of charge or discharge of the accumulators to or from the main circuit, substantially as described.

18930. "Electric apparatus for indicating when machines are in motion, and the speed, work, and the like thereof." J. Blamires and W. Blamires. Dated December 28. 8d. Any and all machines required to examine or test are so arranged as to be capable of being put at will into an electric circuit, or circuits, by means of wire battery (or other electric generator) and switch arrangement, the said machine may carry at some convenient part a tappet, finger, wheel, or other arrangement which is so contrived as to make and break the electric circuit, and thereby allows the transmission of the electric current at every revolution, or other required movement of the machine, or at any period when any given piece of work has been effected by the machine, the said electric current signals, indicates, or records at the switchboard, by any of the usual means of sound or motion, such as striking a bell, deflection of galvanometer, or any other selected device. 2 claims.

18968. "Improvements in and relating to electric primers or igniters for blasting or firing mines, torpedoes, guns, and the like." E. L. Zalinski and H. J. Smith. Dated December 28. 8d. Consists in a primer in which the igniting or initial charge is kept separate from the detonator.

1889.

859. "Improvements in telephonic apparatus." H. F. Jackson and D. Sinclair. Dated January 17. 8d. Has for its object improvements in switchboards for telephonic exchanges, whereby operators may work on opposite sides of the boards, and a largely increased number of subscribers' lines may be operated from a board occupying a given space; and the invention also comprises improvements in the construction and operation of the spring jacks fitted on such boards, and in switches for use on switchboard tables to enable the operators to call subscribers or connect them to the exchange telephone and to each other. 4 claims.

1101. "Improvements in and relating to underground mains for electric conductors." W. Lowrie and C. J. Hall. Dated January 21. 8d. Ordinary pipes, having thimble, flange, or spigot and socket joints, are used. At required points in the line of mains short special castings are provided, which at one end are formed as a spigot, while the other curves outward, like the mouth of a bell. This bell-mouthed end has a flange in the form of a square, and bolt-holes are made in the corners thereof. Other special castings of a similar kind are made with a socket, instead of a spigot end, so as to suit the junction with the adjoining pipes in either direction. The curve of the bell-mouthed ends, and the distance from centres of the corner bolt-holes are the same in all cases, irrespective of the diameter of the pipes of which they form an extension, so that they are interchangeable so far as it relates to their connection with boxes. The boxes used are of different dimensions, but of two kinds. One, which may be called the main or street box, is of a cubical character—all its sides being flat, but with an open bottom—while the other kind is called a branch box, and virtually forms a short piece of the line of pipe in which it is placed. 5 claims.

1112. "Improvements in simultaneous telephony and telegraphy." E. Gwosdeff. Dated January 21. 6d. Claim:—The mode of providing for simultaneously telephoning and telegraphing through one and the same line wire, as herein described, the essential features of novelty being connecting the positive pole of the battery to the earth, and the negative pole to the line, and the employment of double wire electro-magnets for the telegraphic apparatus, the primary wire being connected to the line, and the secondary wire being short circuited on itself, as set forth.

1113. "Improvements in long distance telephony." E. Gwosdeff. Dated January 21. 6d. Claims:—1. A direct line without any intermediate electro-magnets. 2. A line, the extremities of which are insulated from earth. 3. The microphones and the telephones connected through separate condensers to the line and with the earth, or to a return line; in this latter case by means of condensers, the electric capacity of which is in accordance with the respective resistances of the two lines.

1167. "Improvements in and relating to switches and switch connections for electric circuits." W. Lowrie and C. J. Hall. Dated January 22. 11d. Relates to switches and switch connections, especially intended for high potential currents of electricity, whereby such currents may be switched from one circuit to another, or two or more currents combined and directed in any desired manner, with rapidity and safety. 9 claims.

1168. "Improvements in electric current switches." W. Lowrie and C. J. Hall. Dated January 22. 6d. Relates to switches adapted principally for switching on or cutting off the electric current supply of a small installation, such as that of a house. 4 claims.

5816. "Improvements in electrical accumulator or secondary batteries." W. E. Langdon. Dated April 5. 8d. Consists in arranging the cells in such a manner that the fumes shall pass by means of a hole in the top of the lid through a suitably arranged cell or chamber, in the outer chamber of which is placed an alkali, preferably crushed limestone (carbonate of lime). 4 claims.

11705. "A method of and appliances for preventing the loss of surplus electricity generated by dynamo-electric machines for lighting, power, and other purposes." F. W. Englebach and E. B. Bright. Dated July 23. 8d. The principle of the invention is to divert automatically the surplus or unemployed electricity into storage cells or accumulators and thus to convert the loss that occurs on the present system into a profit. 3 claims.

12752. "Improvements in machines for filling secondary battery plates." H. G. Morris, and P. G. Salom. Dated August 13. 8d. The object of the invention is to construct a machine for filling secondary battery plates, the machine being constructed to carry out the process described in patent specification No. 7977, May 31, 1888. 8 claims.

12815. "Improvements in electro-motors." F. V. Andersen and J. O. Girdlestone. Dated August 14 8d. Claims:—(1) An electro-motor constructed and arranged substantially as described with reference to the drawings. (2) In the armature of an electro motor, V grooves for containing the conductors and a continuous layer of iron wire thereon, substantially as and for the purpose described, and as illustrated by the drawings. (3) In an electro motor; the combination and arrangement of gearing for reducing and transmitting the motion of the armature spindle to an auxiliary shaft, such gearing consisting of two or more spur wheels and pinions arranged to break pitch with each other or alternatively, of two pairs of helical wheels and pinions, one of these wheels having a right-hand and the other a left-hand pitch; substantially as described.

15383. "Improved electrodes for secondary batteries." G. E. Heyl. Dated October 1. 4d. Claim:—The use of chromates and wolframates and particularly of alloys of chromium and of alloys of wolfram with other metals respectively for the manufacture of electrodes for accumulators.

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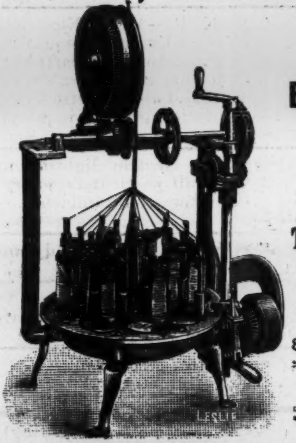

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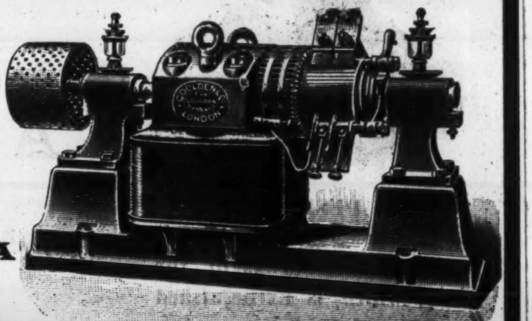

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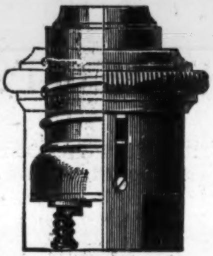

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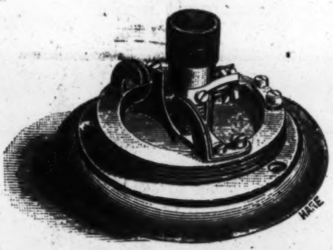

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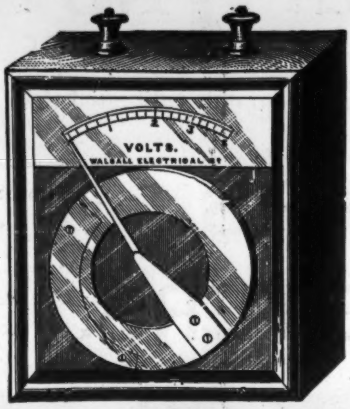

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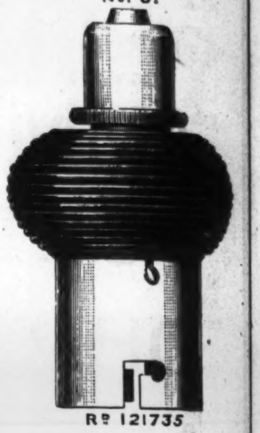

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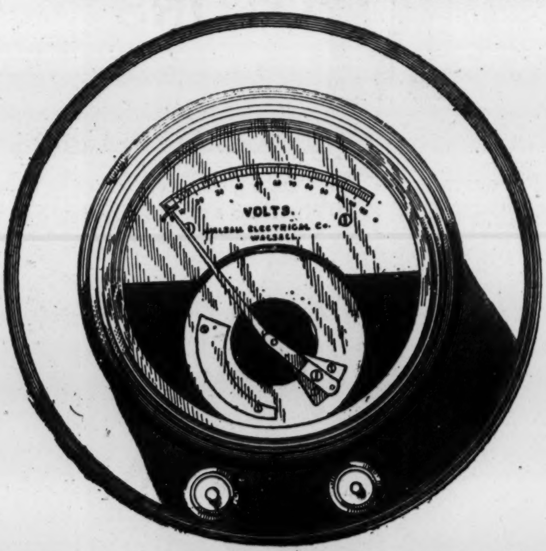

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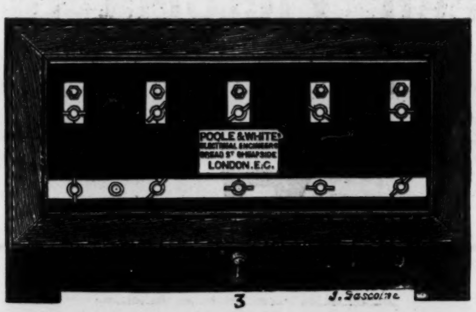

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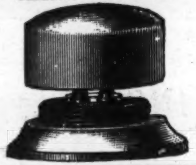

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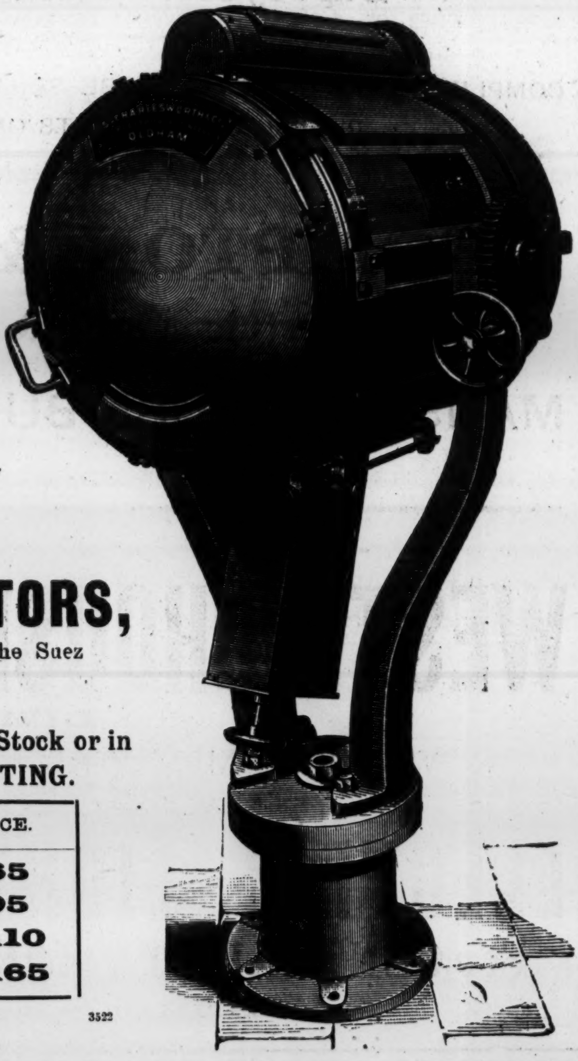

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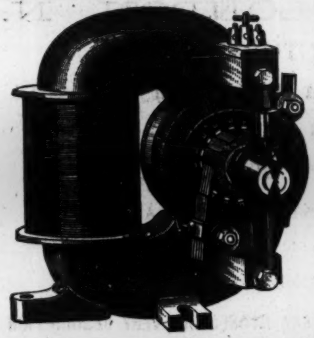

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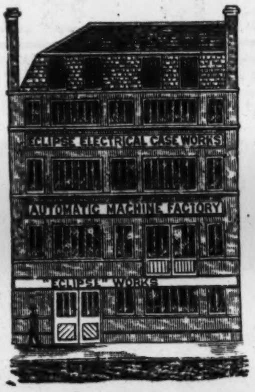

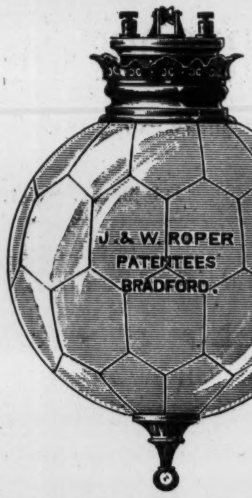

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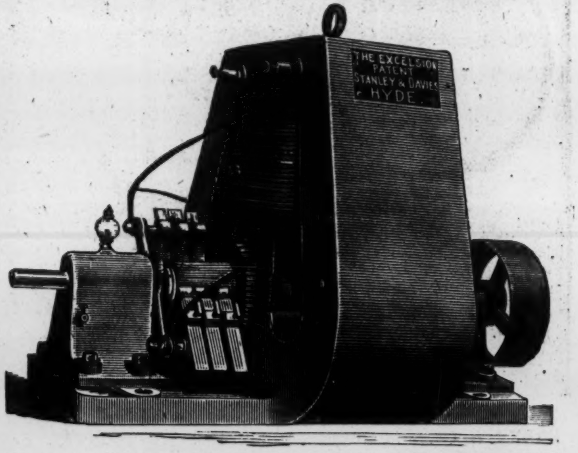

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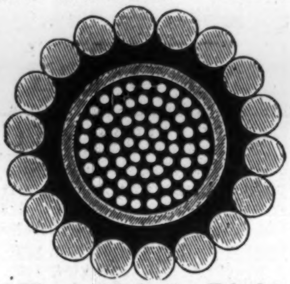

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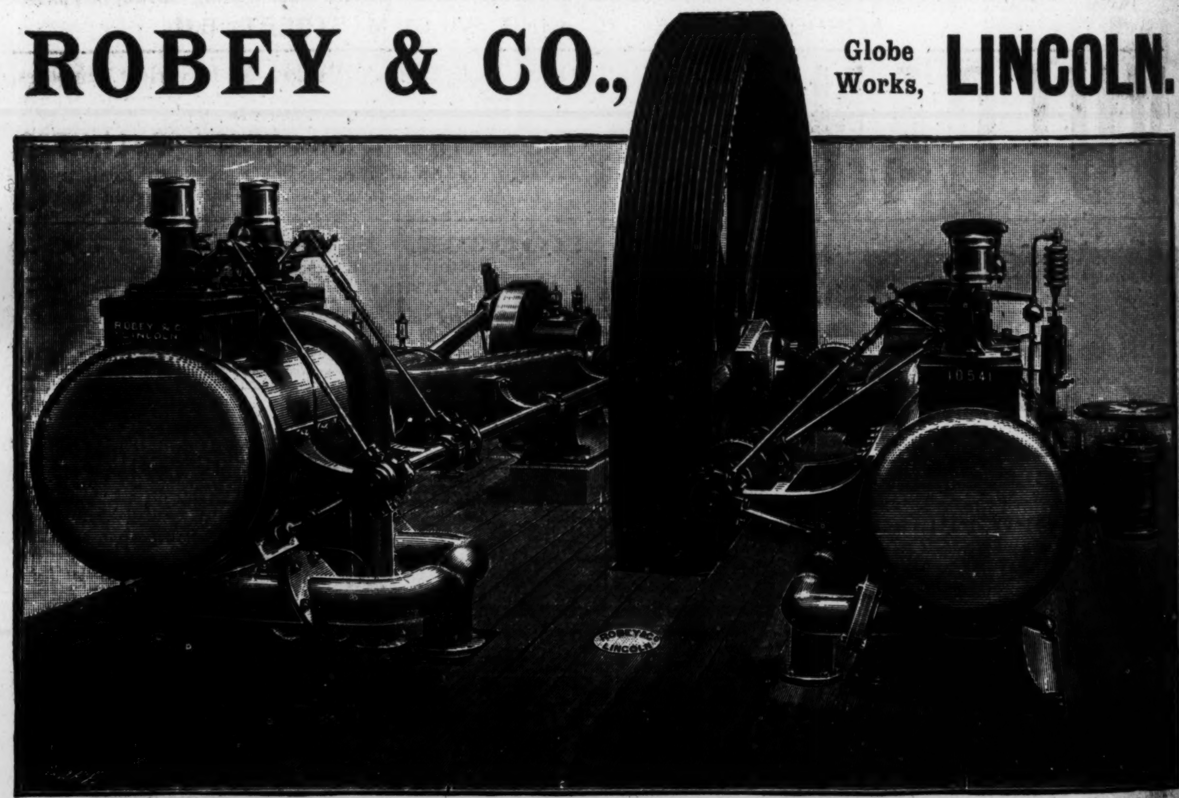

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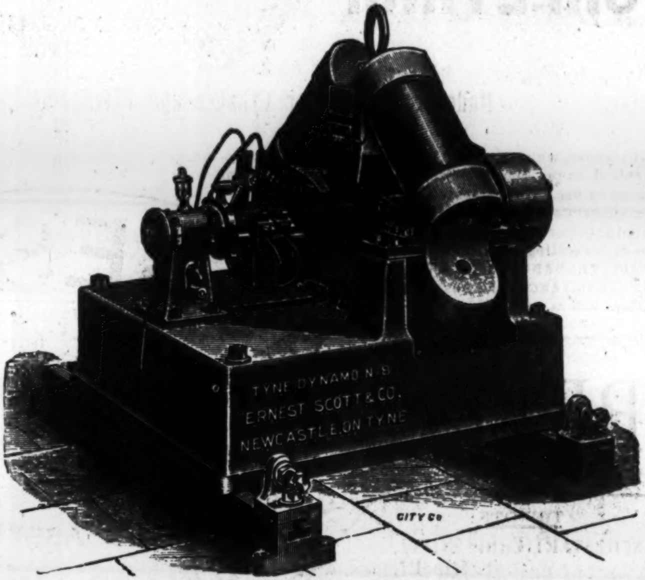

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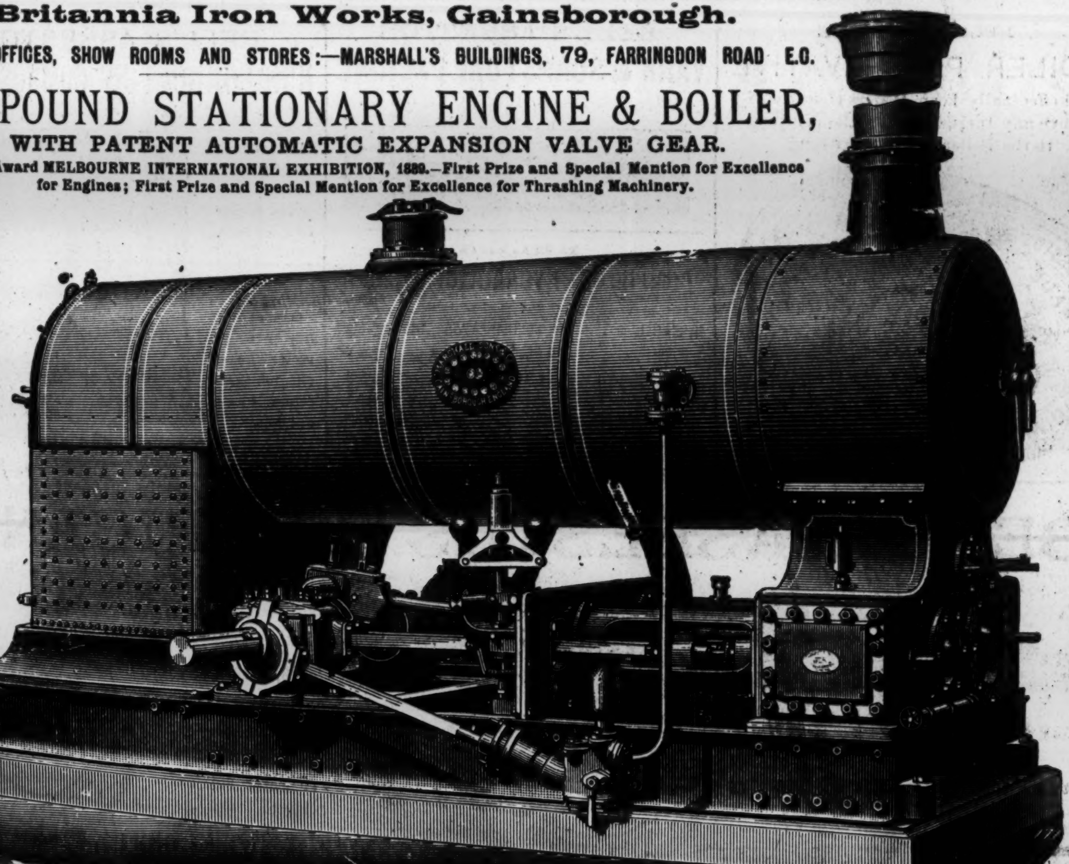

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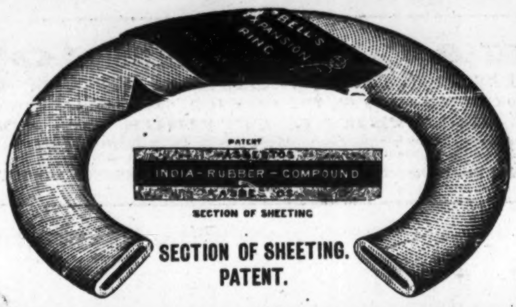

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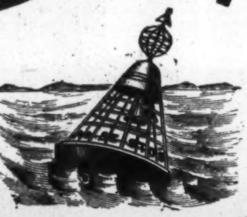

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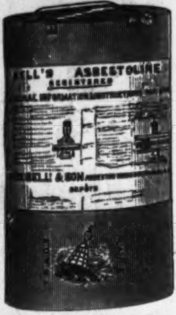

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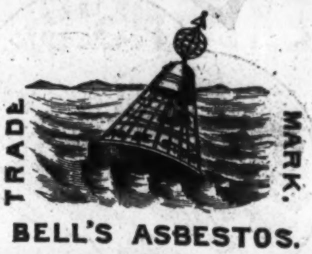

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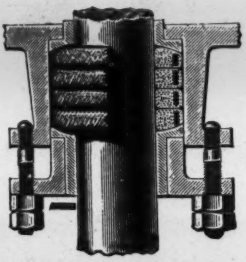

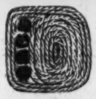

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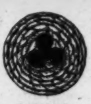

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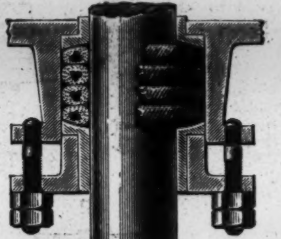

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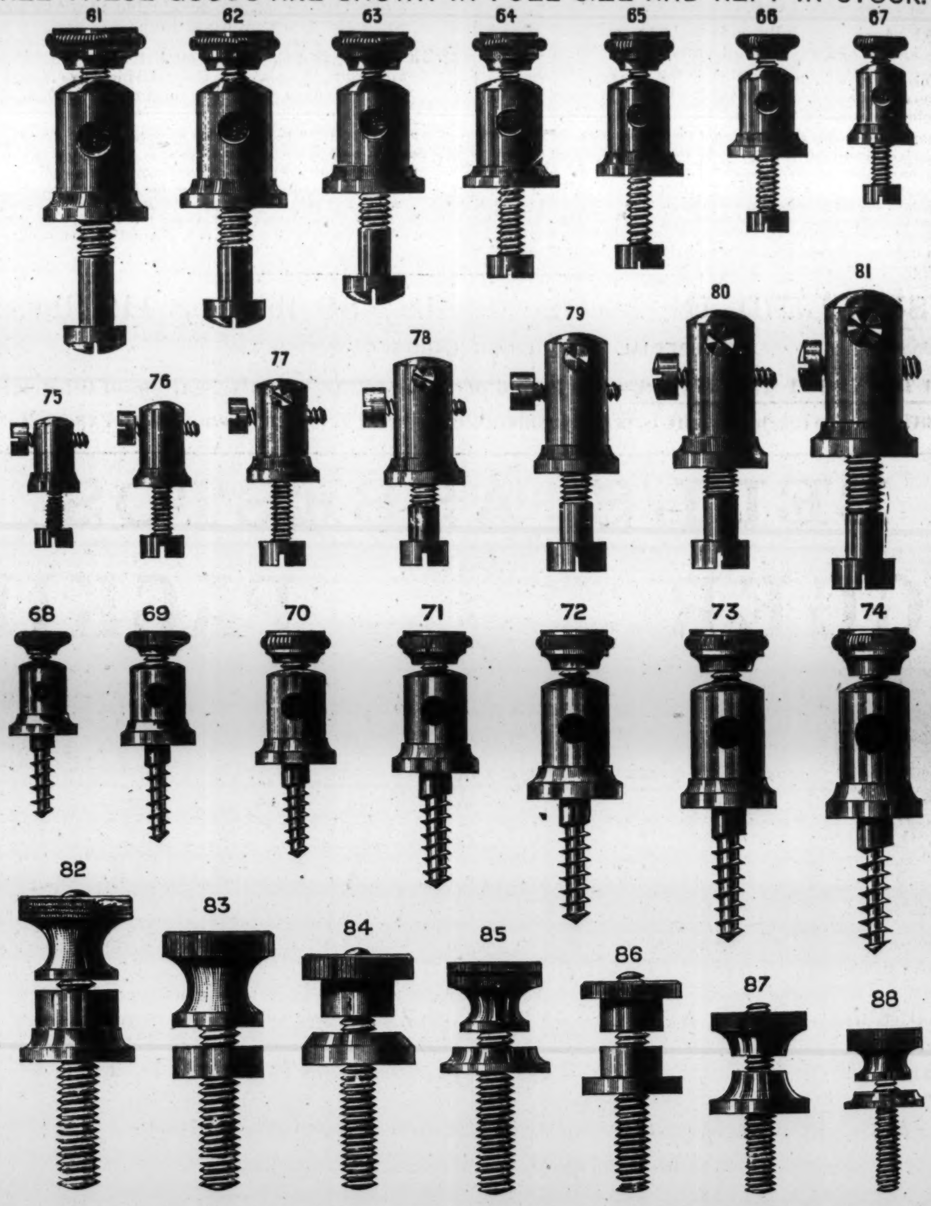

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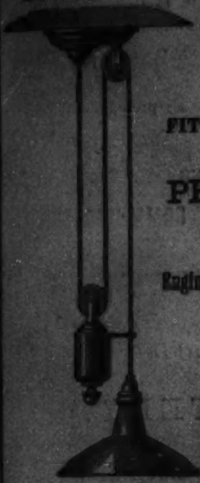

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Printed by E. KNIGHT, 18 and 19, Middle Street, E.C., and Published by the Proprietors, H. ALABASTER, GATEHOUSE & Co., at 22, Paternoster Row, London.